IHS CHEMICAL

Nylon Resins

Chemical Economics Handbook

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Contents

Executive summary

End-use applications for nylon resin fall into two broad categories: fibers and engineering resins. Fiber production from spinning processes yields end-use applications in clothing, carpets, tire cord, and others. Nylon (or engineering) resins are found in diverse uses including automotive and appliance components, electrical power distribution, and a wide variety of consumer goods and packaging film.

In this report, the term *nylon resin* refers predominately to nylon 6 and nylon 66 consumed in engineering applications. By 2020, IHS Chemical forecasts that 8.3 million metric tons of nylon 6 and 66 will be produced. This is an increase of about one million metric tons over the 2015 level, with roughly half of this consumed in nylon resin applications, even though these applications are growing faster than their fiber counterparts. The nylon resin market is estimated to be growing at about 3% per year and is expected to reach 3.3 million metric tons by 2020. Almost 5 million metric tons of nylon will be consumed in fiber applications; although a larger market, it is growing at a slower pace of just 2.2% per year.

In the next five years, China will account for about 40% of the world's nylon production and 32% of the nylon resin consumed globally. China is expected to increase its nylon capacity by 1.6 million metric tons by 2020 and its production by about 6.9% per year, while its consumption of nylon resin is expected to grow at about 5.1% per year for the next five years.

China is a strong producer of nylon 6 and its strength in this market will be compounded in the next five years, with its 2.2 million metric ton fiber market growing at 3.4% per year. This growth will impact other regions or countries, particularly with imports of nylon 6 resin declining.

The Middle East, a major chemical producer, is not yet a major nylon producer. Currently, little nylon 6 is produced in the region, which prefers instead to produce and export caprolactam to China. Saudi Polymers, the first nylon 66 producer in Saudi Arabia, is expected to be operational in 2016, with most of the output to be exported.

As nylon producing regions, North America and Western Europe are expected to remain, at best, stable. Both are important nylon resin consumers, but both regions are growing at below-average rates.

Automotive uses are the largest application for nylon resins, accounting for 36% of the nylon resin consumed in 2015 and predicted to grow at about 2.5% per year for the next five years. The IHS forecast for automobile production shows growth of about 3.1% per year, with 2020 global production surpassing 100 million units. Regions with above-average annual growth rates for vehicle production include the Indian Subcontinent (9.1%), Southeast Asia (5.1%), Central Europe (4.3%), and the CIS and Baltic States (11.8%). The largest vehicle-producing region, Northeast Asia, is expected to grow at the average rate (3.1% per year). Nylon 6 and 66 resins are typically compounded with other materials to improve the material properties.

Further growth in automobile production is likely to support the continued geographic shift in OEM production, thermoplastic compounding, and molding operations, because the manufacture of bulky finished components tends to remain close to the assembly point.

Other smaller applications with above-average growth for nylon resins are electrical/electronic and appliances (about 5% per year).

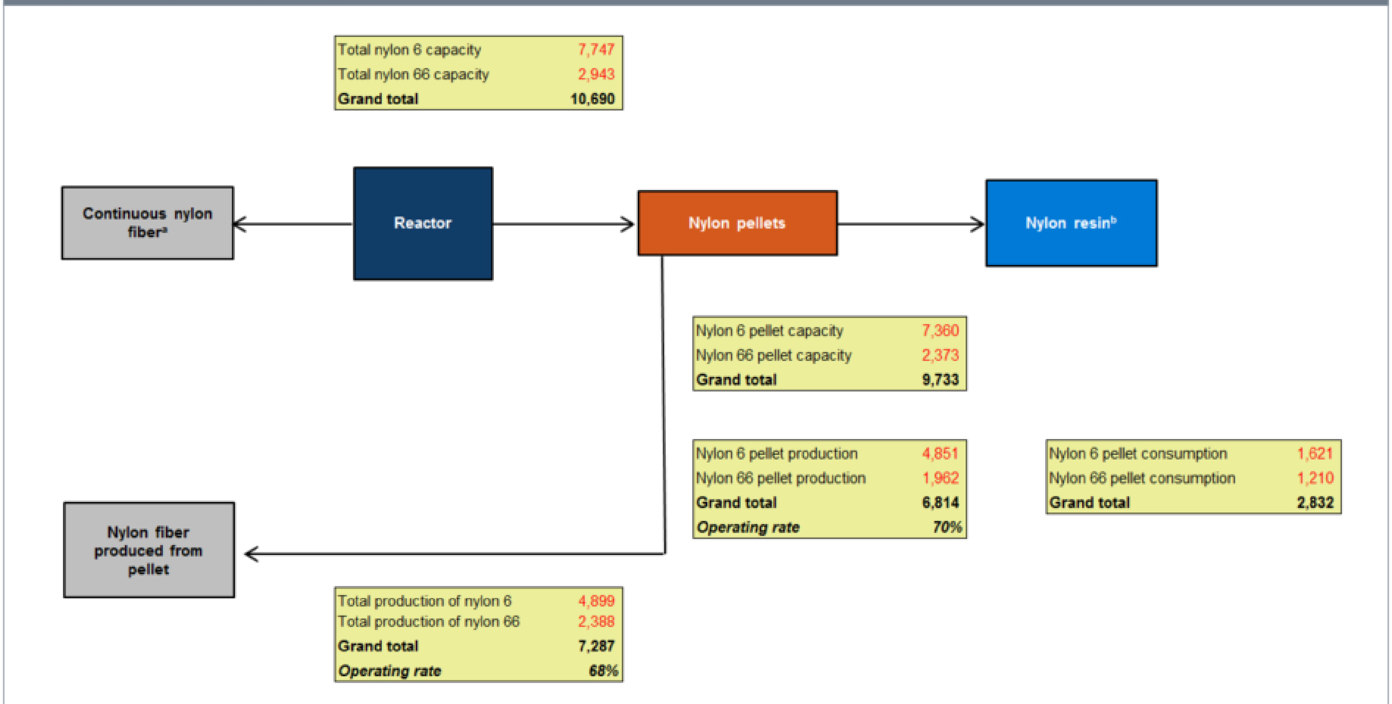
Summary

Total nylon polymerization capacity (including 6 and 66) in 2015 was approximately 10.7 million metric tons. The nylon polymerization capacity includes the fiber capacity as well, and is stated here to give a precise picture of the global nylon capacities. In 2015, the total production of nylon was 7.3 million metric tons.

Total world demand for nylon (6 and 66) resins and fibers was approximately 7.3 million metric tons in 2015, of which nylon resins (6 and 66) accounted for about 2.8 million metric tons. The major producing and consuming regions were North America, Western Europe, and Asia.

Total world consumption of nylon resins is forecast to increase to about 3.3 million metric tons by 2020, representing an average annual growth rate of 3.0%. Good growth is projected in major markets such as automotive parts, electrical/electronics, appliances and consumer products.

Production and product segregation of nylons—2015



a. Is not covered in the subject of this CEH report.
b. Is the main content of this CEH report.

The following table presents world supply/demand for nylon resin:

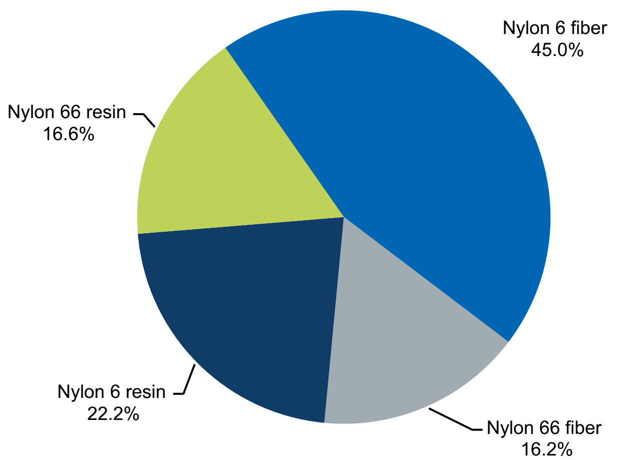
World supply/demand for nylon resin
(thousands of metric tons)

	Annual nameplate capacity			Production	Imports	Exports	Consumption			Average annual consumption growth rate, 2015–20 (percent)
	2013	2015	2020	2015	2015	2015	2013	2015	2020	
Nylon resin										
Nylon 6	6,253	7,360	9,188	4,851	1,375	1,376	1,543	1,621	1,884	3.0
Nylon 66	2,300	2,373	2,675	1,962	1,118	1,117	1,142	1,210	1,398	2.9
Total nylon resin	**8,553**	**9,733**	**11,863**	**6,814**	**2,493**	**2,493**	**2,684**	**2,832**	**3,282**	**3.0%**
Nylon fiber										
Nylon 6	-	-	-	-	-	-	3,143	3,290	3,717	2.5
Nylon 66	-	-	-	-	-	-	1,139	1,182	1,277	1.6
Total nylon fiber	**-**	**-**	**-**	**-**	**-**	**-**	**4,282**	**4,472**	**4,994**	**2.2%**
Total nylon	**8,553**	**9,733**	**11,863**	**6,814**	**2,493**	**2,493**	**6,967**	**7,304**	**8,276**	**2.5%**

Source: IHS Chemical estimates. © 2016 IHS

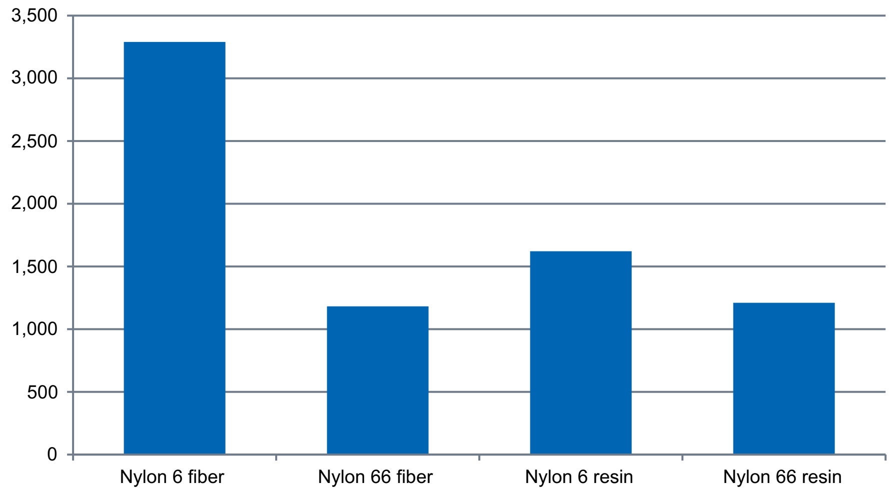
Nylons constitute a family of resins, the most important of which are nylon 6 and nylon 66. The relative consumption of nylons 6 and 66 are summarized in the following charts:

World consumption of nylon by end use—2015



Source: IHS Chemical © 2016 IHS

World consumption of nylon by end use—2015



Notes: Data are in thousands of metric tons
Source: IHS Chemical

This report provides an analysis of the nylon resin markets, which consume about 39% of the nylon resins produced globally. The remaining 61% goes into a variety of fiber applications; these are discussed separately in the CEH *Nylon Fibers* report.

Nylon 6 and 66 resins

Producers

Most producers of nylon resins focus on the production of either nylon 6 or nylon 66; however, there are a few producers that manufacture both resins, such as BASF and Radici.

The following table presents the top producers of nylon 6 resins in the world in order of their capacities; together, these producers accounted for nearly 48% of the total global capacity in 2015:

World top producers of nylon 6—2015
(thousands of metric tons)

Global position	Company	North America	South America	Western Europe	CIS and Baltic States	Northeast Asia	Southeast Asia	Total	Percent of Total
1	BASF Corp.	270	5	255	-	100	-	630	8.6%
2	Li Peng	-	-	-	-	420	-	420	5.7%
3	Liheng Changle	-	-	-	-	300	-	300	4.1%
4	FCFC	-	-	-	-	203	50	253	3.4%
5	DSM Eng. Plastics	60	-	120	-	50	-	230	3.1%
6	Zig Sheng	-	-	-	-	216	-	216	2.9%
7	LANXESS	-	-	210	-	-	-	210	2.9%
8	Fujian Jinjiang Tech.	-	-	-	-	200	-	200	2.7%
9	Xinhui Meida DSM	-	-	-	-	195	-	195	2.6%
10	UBE Industries	-	-	30	-	60	81	171	2.3%
11	Honeywell	170	-	-	-	-	-	170	2.3%
12	KuibyshevAzot	-	-	-	150	-	-	150	2.0%
13	Wuxi Chang'an Polymer	-	-	-	-	140	-	140	1.9%
14	Radici Fibres spA	-	-	113	-	-	-	113	1.5%
15	JSC Grodno Khim.	-	-	-	112	-	-	112	1.5%
Total		**500**	**5**	**728**	**262**	**1,884**	**131**	**3,510**	**47.7%**

Source: IHS Chemical estimates.

The following table presents the top nylon 66 resin producers in the world in order of their capacities; together, these producers accounted for 92% of the total global capacity in 2015:

World top producers of nylon 66—2015
(thousands of metric tons)

Global position	Company	North America	South America	Western Europe	Middle East	Northeast Asia	Southeast Asia	Total	Percent of Total
1	Ascend	500	-	-	-	-	-	500	21.1
2	INVISTA	257	25	90	-	-	-	372	15.7
3	DuPont	220	-	60	-	-	60	340	14.3
4	Solvay-Rhodia	-	80	149	-	55	-	229	9.7
5	BASF	-	-	110	-	40	-	150	6.3
6	Shenma Industrial	-	-	-	-	125	-	125	5.3
8	Radici Chim	-	-	90	-	-	-	90	3.8
9	Asahi Kasei Chem.	-	-	-	-	76	-	76	3.2
10	Jiangsu Shenma	-	-	-	-	63	-	63	2.7
11	Polyamide HP	-	-	58	-	-	-	58	2.4
12	Huafeng Group	-	-	-	-	55	-	55	2.3
13	Nilit	-	-	-	50	-	-	50	2.1
14	Guorui Chemical	-	-	-	-	40	-	40	1.7
15	Fujian Shenma	-	-	-	-	38	-	38	1.6
Total		**977**	**105**	**557**	**50**	**437**	**60**	**2,186**	**92.1%**

Source: IHS Chemical estimates.

Salient statistics

The following table summarizes total world supply/demand for nylons (nylon 6 and nylon 66 combined):

World supply/demand for nylon resin
(thousands of metric tons)

	Annual nameplate capacity			Production[a]	Imports	Exports	Consumption[b]						Average annual consumption growth rate, 2015–20[c]
							2013		2015		2020		
	2013	2015	2020	2015	2015	2015	Fiber	NER	Fiber	NER	Fiber	NER	(percent)
North America													
United States	1,524	1,546	1,576	1,263	86	629	614	326	587	349	614	378	1.6
Canada	154	154	154	101	68	63	86	46	78	44	87	40	-1.9
Mexico	20	20	20	10	101	8	26	76	29	83	27	112	6.2
Total North America	**1,698**	**1,720**	**1,750**	**1,373**	**255**	**700**	**726**	**447**	**694**	**477**	**729**	**530**	**2.1%**
South America	205	160	105	96	74	26	82	106	63	85	62	101	3.5
Western Europe	1,522	1,643	1,653	1,337	269	610	293	688	298	722	297	760	1.0
Central Europe	112	112	190	86	278	155	73	105	82	127	89	145	2.6
CIS and Baltic States	352	370	445	255	25	154	92	57	88	37	83	61	10.1
Middle East	81	114	307	65	100	30	116	39	121	44	138	50	2.9
Africa	-	-	-	-	20	-	-	19	-	21	-	25	3.5
Indian Subcontinent	131	131	131	72	126	6	117	54	134	58	160	87	8.4
Northeast Asia							-						
China	2,545	3,665	5,296	2,218	717	71	2,009	735	2,229	822	2,635	1,053	5.1
Japan	262	242	242	214	133	78	94	182	92	178	92	182	0.5
South Korea	353	261	261	224	152	120	160	105	152	107	148	108	0.2
Taiwan	966	999	1,166	634	81	350	335	35	328	37	327	41	2.2
Total Northeast Asia	**4,126**	**5,167**	**6,965**	**3,290**	**1,083**	**619**	**2,599**	**1,057**	**2,801**	**1,143**	**3,201**	**1,385**	**3.9%**
Southeast Asia	327	327	327	239	262	194	185	113	190	117	235	137	3.3
Total	**8,553**	**9,743**	**11,873**	**6,814**	**2,493**	**2,493**	**4,282**	**2,684**	**4,473**	**2,832**	**4,994**	**3,282**	**3.0%**

a. Production includes nylon resins only

b. The total consumption for nylon 6 and 6,6 (including resins and fibers) in 2013, 2015 and 2020 are approximately 7 million, 7.3 million, and 8.3 million metric tons, respectively.

c. The growth rate for total nylon 6 and 6,6 (including resins and fibers) is 2.5% annually in 2015-2020

Source: IHS Chemical estimates.

Total world nylon resin capacity was approximately 9.7 million metric tons in 2015. This is distributed as follows: Northeast Asia (53.0%), North America (17.7%), Western Europe (16.9%), Southeast Asia (3.4%), and the rest of the world (9.0%).

China is the largest producing country in the world, representing 37.6% of the total world nylon resin capacity. In the next five years, global nylon resin capacity is expected to increase at about 4% per year. China will account for 77% of the 2,130 thousand metric tons of capacity to be added.

The following table presents world supply/demand for nylon 6:

World supply/demand for nylon 6
(thousands of metric tons)

	Annual nameplate capacity			Production[a]	Imports	Exports	Consumption[b]						Average annual consumption growth rate, 2015–20[c]
							2013		2015		2020		
	2013	2015	2020	2015	2015	2015	Fiber	NER	Fiber	NER	Fiber	NER	(percent)
North America													
United States	667	689	719	504	30	120	315	118	309	125	328	133	1.3
Canada	34	34	34	19	29	19	13	17	13	17	14	16	-0.6
Mexico	20	20	20	10	37	8	11	32	14	34	15	46	6.2
Total North America	**721**	**743**	**773**	**533**	**96**	**147**	**338**	**166**	**335**	**176**	**356**	**195**	**2.1%**
South America	75	55	25	19	45	1	33	51	22	41	24	50	4.2
Western Europe	953	1,074	1,084	801	101	358	143	385	147	403	145	421	0.9
Central Europe	112	112	190	86	213	154	49	74	54	91	58	103	2.4
CIS and Baltic States	352	370	445	255	23	154	92	54	88	36	83	58	10.1
Middle East	16	39	182	14	56	16	30	21	29	23	40	26	2.2
Africa	-	-	-	-	5	-	-	5	-	5	-	6	2.8
Indian Subcontinent	131	131	131	72	115	6	117	43	134	47	160	69	8.3
Northeast Asia													
China	2,209	3,234	4,605	1,975	458	25	1,739	469	1,910	522	2,260	658	4.8
Japan	164	144	144	118	44	7	37	125	32	123	31	126	0.5
South Korea	298	206	206	170	74	50	140	64	132	65	128	67	0.4
Taiwan	956	986	1,136	621	9	329	294	14	287	14	283	16	2.0
Total Northeast Asia	**3,627**	**4,570**	**6,091**	**2,884**	**585**	**411**	**2,211**	**672**	**2,361**	**724**	**2,702**	**867**	**3.7%**
Southeast Asia	267	267	267	187	136	129	132	72	120	75	149	88	3.3
Total	**6,253**	**7,360**	**9,188**	**4,851**	**1,375**	**1,376**	**3,143**	**1,543**	**3,290**	**1,621**	**3,717**	**1,884**	**3.0%**

a. Production includes nylon resins only
b. The total consumption for nylon 6 (including resins and fibers) in 2013, 2015 and 2020 are approximately 4.7 million, 4.9 million, and 5.6 million metric tons, respectively.
c. The growth rate for total nylon 6 (including resins and fibers) is 2.8% annually in 2015-2020
Source: IHS Chemical estimates.

Total world nylon 6 resin polymerization capacity was nearly 7.4 million metric tons in 2015. The global capacity for nylon 6 is distributed as follows: Northeast Asia (62.1%), Western Europe (14.6%), North America (10.1%), and the rest of the word (13.2%). China is the largest nylon 6 producer with 43.9% or 3.2 million metric tons of capacity in 2015, but it consumes only 0.5 million metric tons in nylon 6 resin applications. Nylon 6 fiber is a much more important application in China and in the rest of Asia. In the next five years, nylon 6 capacity, driven by nylon fiber demand, is expected to grow at about 4.5% per year, with China accounting for 75% of the growth.

The following table presents world supply/demand for nylon 66:

World supply/demand for nylon 66
(thousands of metric tons)

	Annual nameplate capacity			Production[a]	Imports	Exports	Consumption[b]						Average annual consumption growth rate, 2015–20[c]
							2013		2015		2020		
	2013	2015	2020	2015	2015	2015	Fiber	NER	Fiber	NER	Fiber	NER	(percent)
North America													
United States	857	857	857	759	56	509	298	208	278	224	286	244	1.7
Canada	120	120	120	82	39	44	73	29	66	28	73	24	-2.7
Mexico	-	-	-	-	64	-	16	44	15	49	13	67	6.2
Total North America	**977**	**977**	**977**	**840**	**159**	**553**	**388**	**281**	**359**	**301**	**372**	**335**	**2.2%**
South America	130	105	80	78	30	26	50	54	41	44	38	50	2.8
Western Europe	569	569	569	536	167	252	151	304	152	319	152	340	1.2
Central Europe	-	-	-	-	65	0	24	31	28	36	31	42	3.2
CIS and Baltic States	-	-	-	-	2	-	-	3	-	2	-	3	11.3
Middle East	65	65	115	51	44	13	86	18	92	21	98	25	3.6
Africa	-	-	-	-	15	-	-	14	-	16	-	19	3.7
Indian Subcontinent	-	-	-	-	11	-	-	11	-	11	-	17	8.9
Northeast Asia													
China	336	431	691	243	259	46	269	266	319	300	375	395	5.7
Japan	98	98	98	96	89	71	58	57	60	55	61	56	0.5
South Korea	55	55	55	54	78	70	20	41	20	42	20	41	-0.1
Taiwan	10	13	30	13	72	21	41	21	41	23	43	25	2.3
Total Northeast Asia	**499**	**597**	**874**	**406**	**498**	**208**	**388**	**384**	**440**	**419**	**500**	**518**	**4.3%**
Southeast Asia	60	60	60	52	126	65	53	41	70	42	86	49	3.4
Total	**2,300**	**2,373**	**2,675**	**1,962**	**1,118**	**1,117**	**1,139**	**1,142**	**1,182**	**1,210**	**1,277**	**1,398**	**2.9%**

a. Production includes nylon resins only

b. The total consumption for nylon 66 (including resins and fibers) in 2013, 2015 and 2020 are approximately 2.3 million, 2.4 million, and 2.7 million metric tons, respectively.

c. The growth rate for total nylon 66 (including resins and fibers) is 2.3% annually in 2015-2020

Source: IHS Chemical estimates.

Nylon 66 accounts for 24.4% of the total world nylon resin capacity. The United States is the largest producer of nylon 66, accounting for 36% of the total world capacity. Western Europe has about 24% and China is the third-largest producer with 18% of the world's total.

In the next five years, total nylon 66 capacity is expected to increase to nearly 2.7 million metric tons, with both China and the Middle East adding capacity.

Consumption

Nylon 6 has a somewhat lower heat resistance than nylon 66 but has advantages in aesthetics (especially in reinforced compounds), easier colorability, and historically lower cost. In practice, there is significant overlap in the performance of these two major nylon types. While the preference for 6 versus 66 varies by region, nylon 6 continues to hold the largest volume share of engineering plastic nylon resin globally by virtue of its broad use in production of film used in packaging.

The global consumption of nylons (nylon 6 and 66) in plastics in 2015 was 2.8 million metric tons. The average annual growth rate for the next five years (2015–20) for nylons consumption is forecast to be 3.0%.

Most of the consumption segments listed below utilize/consume both types of nylon resins. Hence, it becomes important to identify those segments where intermaterial competition can play a major role and shape consumption volumes.

The following table presents world consumption of nylon resins by region and end use in 2015:

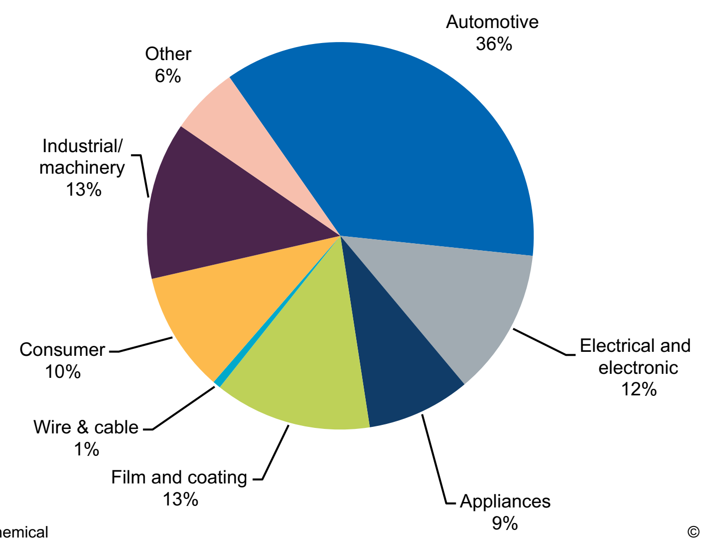
World consumption of nylon resin—2015
(thousands of metric tons)

	Automotive	Electrical and electronic	Appliances	Film and coating	Wire and cable	Consumer	Industrial/ machinery	Other	Total
North America									
United States	172	18	7	59	16	44	21	12	349
Canada	28	1	-	10	1	1	1	2	44
Mexico	58	3	5	1	1	6	2	6	83
Total North America	**259**	**22**	**12**	**69**	**18**	**51**	**24**	**20**	**477**
South America	42	4	6	10	-	5	8	8	85
Western Europe	254	101	43	148	-	64	80	32	722
Central Europe	85	9	5	4	-	3	11	9	127
CIS and Baltic States	18	4	3	3	-	3	6	1	37
Middle East	19	4	4	-	-	3	4	9	44
Africa	10	2	1	-	-	1	2	4	21
Indian Subcontinent	28	7	8	-	0	3	9	4	58
Northeast Asia									
China	154	139	132	60	-	117	178	42	822
Japan	67	26	10	49	-	6	11	10	178
South Korea	46	7	4	28	-	7	10	5	107
Taiwan	5	7	6	4	-	5	6	3	37
Total Northeast Asia	**272**	**179**	**152**	**141**	**-**	**135**	**205**	**60**	**1,143**
Southeast Asia	32	11	9	22	-	13	18	12	117
Total	**1,019**	**343**	**243**	**398**	**19**	**282**	**368**	**160**	**2,832**

Source: IHS Chemical estimates.

The following chart presents the world consumption of nylon resins by end use in 2015:

World consumption of nylon resin by end use—2015



Source: IHS Chemical

The following tables present world consumption of nylon 6 and nylon 66 by end use:

World consumption of nylon 6
(thousands of metric tons)

	Automotive	Electrical and electronic	Appliances	Film and coating	Wire and cable	Consumer	Industrial/ machinery	Other	Total
2005	328	95	77	302	23	119	191	76	1,211
2006	356	102	81	319	22	128	196	76	1,280
2007	421	120	93	338	20	146	206	86	1,430
2008	381	114	87	344	18	131	198	89	1,362
2009	317	102	81	336	13	115	179	70	1,213
2010	390	118	93	356	15	134	200	84	1,391
2011	410	128	103	360	15	142	209	90	1,456
2012	428	132	108	361	16	147	217	93	1,502
2013	442	137	112	365	17	150	223	95	1,543
2014	458	143	117	366	18	156	232	95	1,585
2015	466	150	122	368	19	163	240	93	1,621
2020	538	195	160	380	20	195	282	112	1,884
				Average annual growth rate (percent)					
2015–20	2.9%	5.5%	5.5%	0.6%	1.8%	3.7%	3.3%	3.8%	3.0%

Source: IHS Chemical estimates.

World consumption of nylon 66
(thousands of metric tons)

	Automotive	Electrical and electronic	Appliances	Film and coating	Wire and cable	Consumer	Industrial/ machinery	Other	Total
2005	395	150	79	31	-	91	107	47	899
2006	434	164	100	30	-	114	128	60	1,029
2007	458	168	99	30	-	116	130	60	1,060
2008	425	163	96	29	-	109	119	53	993
2009	368	139	81	24	-	86	95	45	837
2010	451	163	96	28	-	99	110	59	1,005
2011	475	173	104	29	-	105	116	59	1,060
2012	505	176	108	29	-	107	118	61	1,104
2013	526	181	111	29	-	111	121	62	1,142
2014	545	187	115	29	-	115	124	64	1,179
2015	553	194	120	30	-	119	128	66	1,210
2020	615	240	151	31	-	139	145	77	1,398
				Average annual growth rate (percent)					
2015–20	2.1%	4.4%	4.7%	0.7%	—	3.2%	2.6%	3.0%	2.9%

Source: IHS Chemical estimates.

Automotive applications are the demand driver in all global regions, accounting for about 36% of the global nylon resins consumption in 2015.

The following table presents world production of automobiles by region:

World production of automobiles
(millions of units)

	North America	South America	Western Europe	Central Europe	CIS and Baltic States	Middle East	Africa	Indian Sub-continent	North-east Asia	South-east Asia	Total
2000	17.7	2.1	16.9	1.5	1.1	0.7	0.4	0.9	15.4	1.5	58.2
2001	15.8	2.2	17.0	1.3	1.2	0.6	0.4	0.9	15.1	1.6	56.2
2002	16.7	2.0	16.8	1.3	1.1	0.8	0.4	1.0	16.9	1.8	58.9
2003	16.3	2.0	16.7	1.3	1.4	1.2	0.4	1.3	18.0	2.0	60.6
2004	16.3	2.6	16.7	1.6	1.6	1.6	0.5	1.6	19.2	2.3	64.0
2005	16.4	3.0	16.4	1.9	1.7	1.8	0.6	1.8	20.5	2.7	66.7
2006	15.9	3.2	16.1	2.3	2.0	2.0	0.7	2.2	22.7	2.4	69.6
2007	15.5	3.8	16.5	2.9	2.3	2.2	0.7	2.5	24.7	2.5	73.6
2008	13.0	4.0	15.0	3.0	2.4	2.3	0.7	2.5	24.8	2.9	70.5
2009	8.8	3.9	12.0	2.9	1.0	2.2	0.5	2.8	25.4	2.3	61.7
2010	12.2	4.4	13.5	3.2	1.7	2.7	0.6	3.8	32.2	3.3	77.6
2011	13.5	4.6	14.1	3.2	2.3	2.8	0.6	4.1	31.7	3.2	80.2
2012	15.9	4.5	13.0	3.2	2.6	2.0	0.7	4.3	33.9	4.5	84.6
2013	16.6	4.8	13.0	3.4	2.5	1.9	0.8	4.1	36.4	4.5	88.0
2014	17.5	4.0	13.7	3.6	2.2	2.2	0.9	4.0	38.2	4.2	90.6
2015	18.0	3.2	14.5	3.9	1.5	2.6	0.9	4.4	37.9	4.1	91.0
2020	19.6	3.9	14.8	4.8	2.7	3.0	1.2	6.8	44.1	5.2	106.1
					Average annual growth rate (percent)						
2015–20	1.7%	4.2%	0.4%	4.3%	11.8%	3.2%	4.0%	9.1%	3.1%	5.1%	3.1%

Source: IHS Automotive.

Automotive applications consumed about one million metric tons of nylon resins in 2015. Nylon 66 accounted for about 553 thousand metric tons or 54% of the total. Both resin types are well-suited for automotive applications based on their inherent properties. Consumption of nylon resins for automotive applications is growing at a below-average rate of 2.5% in 2015–20, but will account for nearly 30% of the nylon resin volume growth in the next five years.

Applications include a wide variety of interior and exterior hardware and under-the-hood parts that require heat resistance, strength, and good aesthetic appearance. Automotive applications generally require the properties of nylon compounds, which include fiberglass and/or mineral reinforcements, heat stabilizers, and impact modifiers.

Electrical and electronic applications consumed 343 thousand metric tons of nylon resins in 2015. Nylon 66 accounts for 194 thousand metric tons or 56% of the total. This application consumes about 12% of the global demand for nylon resins. The average annual growth rate for nylon resin consumption in electrical and electronic applications will be about 4.9% in 2015–20 and will account for about 20% of the nylon resin volume growth in the next five years.

T a*ppliances* market for nylons is fairly large and is growing. In 2015, appliances consumed 243 thousand metric tons of nylon resin. This application consumes about 8.6% of the global demand for nylon resins. The average annual consumption growth rate for nylon resins in appliances is about 5.1% in 2015–20, accounting for about 15% of the nylon resin volume growth in the next five years.

Film and coating applications are the second-largest market for nylon 6 after automotive applications; very little nylon 66 is consumed for film. About 398 thousand metric tons of nylon resins were consumed in these applications in 2015, with nylon 6 accounting for about 92% of the total. Below-average growth is projected for this application, partly because the markets are mature in the developed world and will expand with population growth.

Film and coating consumed about 14% of the global demand for nylon resins in 2015. The average annual growth rate for nylon resins in film and coating applications is about 0.6% in 2015–20. The primary applications are in flexible packaging for meat and cheese. The film products for these foods require high barrier properties. Nylon is coextruded or laminated with a layer of oxygen barrier material like EVOH. If a polyolefin layer is included in the film structure, a tie layer adhesive material is used between the polymers. The nylon provides puncture, wear, and heat resistance, printability, thermoformability, and aroma barrier properties. BubbleWrap® packing material is another example of a film product with a large nylon 6 component.

Wire and cable applications of nylons are the smallest market overall and consumed about 19 thousand metric tons of nylon resin in 2015. There is no identified demand for nylon 66 in these applications. This application consumed less than 1% of the global demand for nylon resins in 2015 and is growing at about 1.8% per year globally in 2015–20.

Consumer applications consumed 282 thousand metric tons of nylon resins in 2015; nylon 6 accounts for about 58% of the total. This application accounts for about 10% of the global consumption of nylon resins. The average growth rate for nylon resins in consumer applications is about 3.5% per year during 2015–20.

Industrial and machinery applications consumed 368 thousand metric tons of nylon resins in 2015, with nylon 6 accounting for about 65% of the total. China represents nearly half of the global market. This application accounted for 13% of the global demand for nylon resins. The average growth rate for nylon resin consumption in industrial and machinery applications is about 3% per year in 2015–20.

Other applications of nylons consumed 160 thousand metric tons of nylon resin in 2015, representing about 6% of the global demand. The average consumption growth rate for nylon resins in other miscellaneous applications is about 3.4% per year in 2015–20.

Price

The following tables present recent prices for nylon 6 and nylon 66 resins:

World prices for nylon 6
(dollars per metric ton)

	United States (delivered Gulf Coast)	Western Europe (delivered W. Europe)	Northeast Asia (delivered NE Asia)
2007	2,893	2,762	2,543
2008	3,000	2,862	2,502
2009	2,291	2,104	1,866
2010	2,897	2,647	2,863
2011	3,518	3,408	3,584
2012	3,516	2,885	2,733
2013	3,310	2,743	2,512
2014	3,292	2,773	2,426
2015	2,858	2,047	1,940

Source: IHS Chemical estimates. © 2016 IHS

World prices for nylon 66
(dollars per metric ton)

	United States (delivered Gulf Coast)	Western Europe (delivered W. Europe)	Northeast Asia (delivered NE Asia)
2007	3,057	3,249	2,860
2008	3,276	3,443	2,907
2009	2,778	2,741	2,838
2010	3,410	3,321	3,671
2011	3,862	3,895	3,793
2012	3,779	3,345	3,088
2013	3,687	3,262	3,081
2014	3,596	3,211	3,023
2015	3,108	2,387	2,463

Source: IHS Chemical estimates. © 2016 IHS

Prices for nylon resins are affected by the following major factors:

- Cost of raw materials
- Supply and demand for nylon resins
- Energy costs
- Shipments in transportation and packaging
- Addition of additives and modifiers used in the nylon production process

In recent years, nylon pricing exhibited volatility due to supply constraints and variations in demand. Rapid demand growth in China led to increased demand for imports of nylon 6 and 66. During 2010, demand from China began to pull global prices upward and during 2011, several major plant outages in nylon 66 and high caprolactam demand caused prices to spike for both materials.

In 2012, the sovereign debt crisis in Europe and consequent economic stagnation reduced regional demand for nylon and demand for durable goods supplied from Asia that contain nylon. At the same time, large capacity additions for caprolactam and nylon 6 in China led to an oversupply condition. Together, these forces led to a collapse of prices in Europe and Asia back to prerecession levels by 2013. North America, with stronger demand, became more competitive and avoided much of the price collapse. US prices have fallen about 5% per year since the recent peak in 2011, while prices in Western Europe and Northeast Asia have fallen more than 10% per year over the same time period.

Trade

The following tables present the global trade in nylon resins by region for 2014 and 2015:

World trade in nylon resins—2014
(thousands of metric tons)

	Exports by										
Imports by	**North America**	**South America**	**Western Europe**	**Central Europe**	**CIS and Baltic States**	**Middle East**	**Africa**	**Indian Subcontinent**	**Northeast Asia**	**Southeast Asia**	**Total**
North America	171	2	44	2	-	3	-	1	14	5	242
South America	24	15	26	-	1	-	-	-	3	-	69
Western Europe	95	1	-	123	28	16	-	1	9	3	276
Central Europe	4	-	234	14	2	2	-	-	1	-	257
CIS and Baltic States	-	-	24	-	4	-	-	-	-	-	28
Middle East	19	-	41	3	19	-	-	1	8	-	91
Africa	2	-	17	-	-	-	-	-	2	-	21
Indian Subcontinent	15	-	11	-	15	-	-	-	55	14	110
Northeast Asia	307	13	166	3	69	11	-	5	461	154	1,189
Southeast Asia	103	-	22	-	2	-	-	1	103	37	268
Total	**740**	**31**	**585**	**145**	**140**	**32**	**-**	**9**	**656**	**213**	**2,551**

Source: IHS Chemical estimates.

World trade in nylon resins—2015
(thousands of metric tons)

	Exports by										
Imports by	**North America**	**South America**	**Western Europe**	**Central Europe**	**CIS and Baltic States**	**Middle East**	**Africa**	**Indian Subcontinent**	**Northeast Asia**	**Southeast Asia**	**Total**
North America	180	2	47	5	-	2	-	-	13	6	255
South America	32	11	27	-	2	-	-	-	2	-	74
Western Europe	80	-	-	133	36	9	-	1	9	1	269
Central Europe	8	-	253	11	3	2	-	-	1	-	278
CIS and Baltic States	-	-	23	-	2	-	-	-	-	-	25
Middle East	18	-	53	3	15	5	-	1	7	-	102
Africa	3	-	15	1	-	1	-	-	1	-	21
Indian Subcontinent	13	-	14	-	22	-	-	-	66	11	126
Northeast Asia	265	13	160	2	72	11	-	3	410	147	1,083
Southeast Asia	101	-	18	-	3	-	-	1	110	29	262
Total	**700**	**26**	**610**	**155**	**155**	**30**	**0**	**6**	**619**	**194**	**2,495**

Source: IHS Chemical estimates.

Trade data do not distinguish nylon 6 and nylon 66. The trade volumes discussed in the following sections include total nylon resins for all applications.

In the last five years, nylon trade has been growing at about 2.5% per year. However, in 2015, trade volumes actually dipped, falling below 2.5 million metric tons from the previous year of 2.55 million metric tons. In the next five years, trade in nylon resin is expected to decline further to about 2.2 million metric tons.

In 2015, the largest exporting regions were Northeast Asia (619 thousand metric tons), North America (700 thousand metric tons), and Western Europe (610 thousand metric tons), accounting for a combined total of about 1.93 million metric tons, or about 77% of the total global exports. Southeast Asia (194 thousand metric tons) and Central Europe and the CIS (155 thousand metric tons each) have also contributed significantly to the global exports.

In 2015, the global imports were heavily concentrated in Northeast Asia, with China being the main recipient of nylon resins. Northeast Asia imported about 1.1 million metric tons (43% of total imports) in 2015; imports are expected to increase due to the growth in the region. North America (255 thousand metric tons), Western Europe (269 thousand metric tons), and Central Europe (278 thousand metric tons) also imported large volumes of nylon resins in 2015.

Strategic issues for nylon 6 and nylon 66

The strategic issues surrounding nylon resins mostly revolve around supply chain complexity.

- In the past, there has been a shortage in the nylon 6 precursor, caprolactam. Growing demand and some unplanned outages led to a tight supply situation and high prices for caprolactam in 2010 and early 2011. However, new caprolactam capacities planned in China will ease the supply situation in the future years.

- The expansion of nylon 66 capacity is dependent on the availability of intermediate materials. Adipic acid is readily available, but the adiponitrile (ADN) and hexamethylenediamine (HMDA) supply relies on only a few companies, and the technology is closely guarded. Only INVISTA, Butachemie (INVISTA/Solvay joint venture), Ascend Performance Materials, and Asahi Kasei make the HMDA precursor ADN. Other producers, including the announced new nylon 66 plants in China, Taiwan, and Saudi Arabia are nonintegrated and must be able to buy adiponitrile, HMDA, or nylon salt in order to make nylon 66.

- In recent years, the nylon 66 plants in Asia have not been able to run at high rates due to production-related shortages of nylon intermediates. Concentration of production in a few plants, some of which are located on the hurricane prone US Gulf Coast, has been a supply concern in the past. This concentration is also apparent in the control of technology to convert butadiene to ADN, with about 80% of ADN capacity held by a single company, INVISTA. So, to some extent, INVISTA's willingness to invest in new capacity as they are doing in Shanghai (China), sets the strategic pace of global nylon 66 volume growth.

- The production of HMDA is also in the hands of only a small number of companies and plants—the four ADN producers, plus companies capable of converting ADN to HMDA, such as SSME in Russia, Radici in Italy, BASF in the United Kingdom, and Shenma in China. Constrained availability of HMDA limits the viability of nonintegrated nylon 66 producers. Consolidation is one possible outcome for the nonintegrated facilities. In 2011, Shenma acquired two smaller nylon producers in China, formerly customers, that had purchased HMDA and/or nylon salt from them. Close relations with suppliers is a necessity.

- HMDA itself is made from adiponitrile, and nearly 80% of global adiponitrile capacity is based on butadiene, a by-product of ethylene production. Adiponitrile accounts for less than 6% of global butadiene demand. The ethylene cracker feedslates in North America have been shifting from naphtha toward lighter and cheaper natural gas–derived feed. The lighter feedstocks, while improving margins for ethylene producers, generate less by-product crude C_4 from which butadiene is derived. The decline of crude C_4 production in North America has been large enough to change the region's trade position from a net exporter to a net importer, and to put pressure on the global butadiene supply. Following the current hiatus, butadiene prices are expected to continue to move upward, based on the projected tight global supply.

- For butadiene, "on-purpose" routes that had existed in the past were displaced by much more economical by-product crude C_4, and almost all on-purpose facilities were shut down. New economics in a butadiene-scarce environment and the direction in which prices may be headed gave rise to new ideas and a reconsideration of the potential for on-purpose routes. One butadiene supplier, TPC Group, has started engineering work on reactivating an idled dehydrogenation plant as part of an on-purpose 270 thousand metric ton-per-year facility that will use normal butane, a natural gas liquid, as feedstock. The plant, small relative to total demand, was expected to come onstream in 2015, but remains idled. It is important to note that China's coal-to-olefins projects open the possibility to dehydrogenate by-product butylenes to butadiene. Several of these types of facilities are in planning.

- Other new ideas involve bio-based and renewable routes to butadiene. Recently, Genomatica and partner Versalis raised $41.5 million for development of plant-based butadiene technology, which they plan to demonstrate and license. INVISTA and Lanza have announced a joint development agreement to develop butadiene from waste gas carbon monoxide–derived 2,3-butanediol and eventually directly from carbon monoxide. Strategically the new technologies are important. However, global butadiene supply constraints will likely moderate with growing ethylene production in Northeast Asia, where plants are typically using naphtha feedstock, which generates higher volumes of crude C_4 by-products. These additional supplies will take some time to impact the global market and supply constraints will likely persist in the near term.

- The remaining ADN capacity is based on propylene through intermediate acrylonitrile. Ascend Performance Materials and Asahi Kasei use this process as a starting point for their HMDA production. Propylene supply, also a by-product of ethylene production, has been reduced due to lighter feedslates as well. However, in the case of propylene, there are several existing "on purpose" alternate processes, and new facilities are coming onstream using these technologies to make up for the shortfall from by-product production. Ascend has announced their intention to invest in a 1.2 million metric ton propane dehydrogenation facility to make propylene from the now-abundant natural gas liquid. This backward integration is expected to supply low-cost feedstock for Ascend's acrylonitrile production, which is feedstock for ADN.

Specialty nylon resins

The nylons market is dominated by nylon 6 and nylon 66 due to their higher volume of production and applications. Specialty nylon resins are consumed in much smaller quantities and cater mostly to niche markets. Specialty nylons are produced mainly in the United States, Western Europe (France, Germany, the Netherlands, Spain, and Switzerland), and Japan, although other regions may also have production capabilities.

Please note that the following is intended to present an overall picture of the niche markets for these types of nylon resins. Specialty nylons are discussed only in the following summary and are not delved into in the rest of this report.

Types

Currently, the category of nylons includes the following types:

- Nylon 11, 12, 610 and 612 with longer aliphatic chains.
- Nylon MXD6®, a semiaromatic nylon made from meta-xylylenediamine and adipic acid by Mitsubishi Gas Chemical Company Inc. and often referred to as amorphous nylon.
- Semiaromatic nylons and polyphthalamide (PPA), made from terephthalic acid and hexamethylenediamine by Mitsui Chemicals (ARLEN®), DuPont (Zytel HTN), and Solvay Advanced Polymers (Amodel®). Nylon 9T is made from nonandiamine and terephthalic acid by Kuraray.
- Nylon 46, produced solely by DSM in the Netherlands.

These specialty nylon resins are of different types and the basic production technique of these resins is listed below:

- Nylon 46 resin is produced by reacting 1,4-diaminobutane with adipic acid. 1,4-Diaminobutane is derived by reacting acrylonitrile with hydrogen cyanide and subsequent reduction of the intermediate.
- Nylon 69 resins are produced (via an intermediate) from hexamethylenediamine and azelaic acid ($HOOC\text{-}[CH_2]_7\text{-}COOH$). Azelaic acid is typically derived from tallow (via oleic acid).
- Nylon 610 resins are produced (via an intermediate) from hexamethylenediamine and sebacic acid ($HOOC\text{-}[CH_2]_8\text{-}COOH$). Sebacic acid is usually derived from castor oil.
- Nylon 612 resins are produced (via an intermediate) from hexamethylenediamine and dodecanedioic acid (DDDA) ($HOOC\text{-}[CH_2]_{10}\text{-}COOH$). DDDA is most often derived (via cyclododecane) from butadiene. Copolymer 612 resins are prepared from DDDA, caprolactam, HMDA, adipic acid, and/or other materials.
- Nylon 11 resins are obtained from the self-condensation of 11-aminoundecanoic acid ($H_2N\text{-}[CH_2]_{10}\text{-}COOH$), which is typically derived from castor oil.
- Nylon 12 resins are obtained from laurolactam in much the same manner in which nylon 6 is obtained from caprolactam. Laurolactam is usually derived (via cyclododecane) from butadiene.
- PPA (polyphthalamide) is a copolymer made from terephthalic, isophthalic, and adipic acids and hexamethylenediamine. These are all readily available commercial monomers. These products may be amorphous or semicrystalline and typically have 55–60% minimum (mol %) of the acid portion (either isophthalic or terephthalic acid). Terephthalic acid or isophthalic acid are aromatic chemicals that serve to raise the melting point and glass transition temperature, and generally improve chemical resistance versus standard aliphatic nylon polymers.
- Nylon 9T resin is produced by polycondensation of nonandiamine and terephthalic acid.
- Nylon MXD6 resin is produced by polycondensation of m-xylylenediamine and adipic acid.

Amorphous nylons include various polymers that typically have high clarity properties. Some amorphous nylons are thought to be produced from hexamethylenediamine and specific proportions of isophthalic and terephthalic acids. Other producers may manufacture amorphous nylon from hexamethylenediamine and diphenylisophthalate. Some grades of amorphous nylon may also be produced by a reaction involving a mix of adipic and azelaic acids and a diisocyanate instead of a diamine. Others use 2,2,4- and 2,4,4-trimethyl-hexamethylenediamines.

Producers

The following table presents the world producers of specialty nylon resins, with locations and estimated capacities:

World producers of specialty nylon resins

Company	Location	Total capacity[a]	Products	Remarks
Arkema Inc.	Birdsboro, PA, US	15	Nylon 11 Nylon 12	
	Serquigny, France	40	Nylon 11 Nylon 12	Includes some nylon 6 compounding.
	Zhangjiagang, China	15	Nylon 1010	
Ascend Performance Materials	Cantonment (Pensacola), FL, US	20-40	Nylon 66 Nylon 69 Nylon 610	Vydyne® nylon 66 and 66/6 copolymers and amorphous compounded nylons; Ascend® resins for film and similar uses; produces adipic acid and hexamethylenediamine. Also compounds at Foley, Alabama and Greenwood, South Carolina.
CFP Flexible Packaging S.p.A	Pisticci Scalo, Italy	10	Nylon 612	For films.
DSM Engineering Plastics B.V.	Geleen, Netherlands	50	Nylon 46	
DuPont Engineering Polymers	Chattanooga, TN, US	25-50	PPA Amorphous nylon	
	Parkersburg, WV, US	16	Nylon 6 Nylon 66 Nylon 612 Amorphous nylon	Zytel® 66 and 612; Minlon® mineral-reinforced nylon; amorphous nylon; nylon monofilament; Selar® nylon barrier resins.
	Richmond, VA, US	6	Nylon 66 PPA	Zytel® HTN. Lines in Texas and Canada producing HMDA and adipic acid now belong to INVISTA.
EMS Group	Sumter, SC, US	10	Nylon 6 Nylon 12 PPA Amorphous nylon Nylon 612	Grilon® nylon 6; Grilon® C Nylon 612, 6/69, 66/610 (purchased or imported) copolymers; Grilamid® nylon 12, Grivory® polyarylamide amorphous nylon copolymers; Griltex® copolyamide thermoplastic adhesives. Compounds Grilon® T Nylon 66.
	Domat Ems, Switzerland	52	Nylon 6, 66, and 12, PPA, and copolymers	
Evonik Degussa GmbH	Marl, Germany	12	Nylon 12	Expansion (6 thousand metric tons) expected in 2017.
	Singapore	0	Nylon 12	Project (20 thousand metric tons) slated for 2015 was abandoned.
Jarden Applied Materials	Columbia, SC, US	5	Nylon 6 Nylon 66 Nylon 69 Nylon 612 Nylon 610	Isocor® polyamide resins. Shakespeare nylon 6, 66, 69, 610, and 66/6 copolymers and terpolymers.
Kuraray Co., Ltd.	Kashima, Ibaraki, Japan	6	Nylon 9T	Genestar®.
	Saizyou Ehime, Japan	6	Nylon 9T	Genestar®.
Mazzaferro Tecnopolímeros Ltda.	Brazil	13	Nylon 6 Copolymers of 6/66, 610, and 612	Capacity includes 2 thousand metric tons of nylon 6 engineering plastics.
Mitsubishi Gas Chemical Company, Inc.	Niigata, Niigata, Japan	15	Nylon MXD6e	Including capacity for nylon film polymer.
Mitsui Chemicals, Inc.	Kuga-gun, Yamaguchi, Japan	6	Nylon 6T	Arlen®.
Monosuisse AG	Switzerland	10	Nylon 66 and 610 polymer	
Solvay Advanced Polymers	Düsseldorf, Germany	6	Polyacrylamide	Partially aromatic nylon.
	Augusta, GA, US	11	PPA	Amodel® polyphthalamide production is substantially less than nameplate capacity.
Tai-Young Nylon	Kaohsiung, Taiwan	12	Nylon 6 Copolymers of 6/66	Novamid® polyamide.
Toray Industries, Inc	Nagoya, Aichi, Japan	1	Nylon 610	Amilan®.
UBE Engineering Plastics, S.A.	Castellón, Spain	10	Nylon 612 and 6/66 copolymers	May include capacity for fibers.
Ube Industries, Ltd.	Ube, Yamaguchi, Japan	10	Nylon 12	Ubesta®.
Total		**382-427**		

a. Capacity may include production of nylon 6 and nylon 66 as indicated. Estimated capacities for specialty nylons were derived by eliminating the nylon 6 and nylon 66 capacities from the total capacities for these producers.

Source: IHS Chemical estimates.

United States has up to 500 thousand metric tons of specialty nylon capacity, although the majority of this is shared with conventional nylon production; about 15–20% of this capacity is actually available to manufacture the specialty nylons.

- Arkema produces nylon 11 and nylon 12 with 15 thousand metric tons of capacity.
- Ascend produces predominately nylon 66 at Cantonment, Florida; however, they also have the capability to produce nylon 69 and 610. Estimated specialty nylon capacity is 20–40 thousand metric tons.
- DuPont produces nylon 6 and 66, but can also produce nylon 612 and PPA at all of its three facilities in the United States. Estimated specialty nylon capacity is 25–50 thousand metric tons.
- EMS produces a range of specialty nylons; in the United States the estimated capacity is approximately 10 thousand metric tons.
- Jarden Applied Materials produces a variety of nylon copolymers and terpolymers (Isocor©), with a total capacity of about 5 thousand metric tons per year.
- Solvay Advanced Polymers produces polyphthalamide (PPA) at the US plant in Augusta, Georgia, with an approximate capacity of 11 thousand metric tons. The product is sold under the trade name Amodel©.

Western Europe has up to 215 thousand metric tons of specialty nylon capacity, although the majority is shared with conventional nylon production; about 80% of this is actually available to manufacture the specialty nylons.

- Ube produces caprolactam for captive nylon 6 production in Spain and also produces Ubesta© polyamide 12, which is used in manufacturing optical fiber cables, conventional cables, antitermite cables, and “bite”-resistant cables.
- Arkema and Evonik Degussa are the big producers of laurolactam in Western Europe, used for the production of nylon 12. In 2009, Evonik Degussa expanded laurolactam capacity at Marl, Germany. Evonik had an additional laurolactam expansion in the fourth quarter of 2011.
- In 2006, Arkema announced a restructure in its performance products segment, which led to the closure of its Rilsan® polyamide facility in Bonn, Germany in 2008.
- Evonik had a fatal explosion at their CDT facility in Marl, Germany in March 2012, which significantly reduced production of key intermediates for nylon 12 and resulted in a supply crisis. Operations were restored in early 2013.
- Evonik plans to expand nylon 12 capacity at Marl, Germany by 50% (to 18 thousand metric tons) by 2017.
- Having already established its polymer in the automotive markets, DSM has introduced Stanyl® ForTii (4T), a nylon 46 copolymer with improved heat resistance and reduced moisture absorption for electronic applications Production capacity at Geleen, Netherlands was quadrupled in late 2009 to accommodate anticipated growth, and is currently about 50 thousand metric tons per year.

Japan has approximately 40–44 thousand metric tons of specialty nylons capacity, which is about 10% of the total nylons capacity in the country.

- Ube produces nylon 12 from laurolactam, which has been provided captively since 1992. Toray produces nylon 610 in a small-scale facility.
- Semiaromatic nylons are produced by Mitsubishi Gas Chemical Company, Inc. and Mitsui Chemicals from aromatic diamine components (by the former) and aromatic diacid components (by the latter).
- Three other companies (Asahi, Toray, and Ube) are reported to be developing similar semiaromatic nylons from aromatic diacid components.

- Kuraray is the only producer of nylon 9T in the world, developed under the trade name Genestar© in 1999. Nylon 9T is produced by polymerization of nonandiamine and terephthalic acid. Kuraray established a commercial plant at Ehime Prefecture in 2000, with a capacity of 2.0 thousand metric tons. The plants were expanded several times at Ehime, to 4.0 thousand metric tons in 2005 and 5.5 thousand metric tons in 2007. Moreover, a new plant was built in Ibaraki Prefecture in 2008. Total capacity for nylon 9T at the end of 2009 was 11 thousand metric tons per year.

The overall capacity of specialty nylons is estimated to be around 382–427 thousand metric tons in 2015.

Salient statistics

The following table presents estimated global supply/demand for specialty nylons:

World supply/demand for specialty nylons[a]
(thousands of metric tons)

	Annual nameplate capacity			Production	Imports	Exports	Consumption			Average annual consumption growth rate, 2015–20 (percent)
	2013	2015	2020	2015	2015	2015	2013	2015	2020	
North America										
United States	108	108	108	75	-	19	55	56	75	6.0
Canada	-	-	-	-	-	-	-	-	-	-
Mexico	-	-	-	-	4	-	4	4	6	8.4
Total North America	**108**	**108**	**108**	**75**	**4**	**19**	**59**	**60**	**81**	**6.2%**
South America				-						
Brazil	13	13	13	8	-	2	6	6	8	5.9
Other	-	-	-	-	1	-	1	1	1	4.6
Total South America	**13**	**13**	**13**	**8**	**1**	**2**	**7**	**7**	**9**	**5.7%**
Western Europe	190	190	196	118	-	20	96	98	130	5.8
Central Europe	-	-	-	-	7	-	7	7	9	5.2
CIS and Baltic States	-	-	-	-	5	-	5	5	7	7.0
Middle East	-	-	-	-	-	-	-	-	-	-
Asia				-						-
India Subcontinent	-	-	-	-	-	-	-	-	-	-
China	15	17	22	12	19	2	28	29	42	7.7
Japan	44	44	44	27	-	3	23	24	30	4.6
South Korea	-	-	-	-	5	-	5	5	7	7.0
Taiwan	12	12	12	7	5	0	12	12	16	5.9
Southeast Asia	-	-	-	-	-	-	-	-	-	-
Total Asia	**71**	**73**	**98**	**46**	**29**	**5**	**68**	**70**	**95**	**6.3%**
Total	**382**	**384**	**415**	**247**	**46**	**46**	**242**	**247**	**331**	**6.0%**

a. These data are estimated based on the specialty nylons market information.

Source: IHS Chemical estimates.

The average global operating rate is estimated at 60–70% in 2015, resulting in the production of 247 thousand metric tons of specialty nylons.

The global trade is estimated at 46 thousand metric tons in 2015.

Consumption was about 247 thousand metric tons in 2015 and is expected to increase to 331 thousand metric tons by 2020 at the rate of 6.0% per year globally.

Consumption

The majority of specialty nylon consumed in the United States is nylon 11 and 12, polyphthalamide, and imported nylon 46.

- Nylons 11 and 12 are noted for their low water absorption and adhesive properties. The primary uses for nylons 11 and 12 are in flexible tubing and hose for automotive and instrument applications. They are used in a variety of small molded parts for fuel systems (e.g., fuel rails, couplings, and fuel lines) and other miscellaneous applications (e.g., brake lines).

- Polyphthalamide is used in automotive applications such as motor end frames, emission control valve housings, transmission stub tubes, low-profile fog lamps, and water pump housings.

- Nylon 46 has excellent mechanical properties due to its high crystallinity and is used in automotive parts, computers, and personal electronics.

Tubing and pipe may be semiflexible (plasticized nylon 6, nylon 11, nylon 12, or nylon 612) or rigid (nylon 6 or 66). Typical uses are in automotive components (e.g., in air conditioners or as radiator overflow tubing), as coiled tubing on compressed air tools, and in food-processing equipment. Nylon 11 is used primarily in air brake tubing and nylon 12 is used in automotive fuel tubing. Other uses for nylon 11 and 12 include sheathing for automotive brake cables and coiled pneumatic tubing. Moderate growth is expected to continue in automotive tubing applications such as air conditioners and fuel systems. Due to its heat and chemical resistance, nylons benefit from the trend toward fuel systems that can withstand the corrosive effects of reformulated fuels containing alcohols and other oxygenates.

A big challenge in automotive fuel system tubing applications is permeation resistance. Tougher emission regulations for automotive fuel systems have prompted the development of multilayer, coextruded nylon 12/fluoropolymer tubing with higher permeation resistance. Also, automotive brake lines use steel tubing with nylon 12 coating. Some extruded nylon 66 is also used as convoluted tubing in automotive air management and wire management applications.

Fuel tubes are the key application in Japan. Nylon 11 and nylon 12 are desirable for this application. Due to low permeability requirements in Japan, a single-layer tube of nylon is not enough for this requirement. Therefore, special multilayer tubes such as nylons/fluoropolymers have been researched. These resins are also used in hot-melt adhesives for clothing, as well as in coatings for optical fibers.

In industrial applications, significant use of nylon tubing is believed to be in offshore gas and oil production where nylon 11 extrusions transport various fluids. Other uses include hydraulic and pneumatic tubes and pipe for the distribution of natural gas. All of these uses, however, may be more frequently practiced outside the United States, such as in North Sea production; likewise, significant growth of nylons and pipe/tubing for these applications may also occur largely in Europe and Asia.

Nylon 11 is also used in powder coatings for a number of industrial and consumer products where corrosion protection, toughness, and other properties are desired. Powder coatings are made by cryogenic grinding of resin; the product to be coated is heated, dipped into the fluidized powder, removed, and heated to yield a protective layer. Use of nylon powder coatings is relatively small compared with thermosetting coatings (e.g., epoxies, polyesters), since they are significantly more expensive. In another application, modified nylon copolymers are used to bind filaments into thread and improve their abrasion resistance.

Nylons 11 and 12 are used as molded and extruded products in the transportation and electrical/electronic markets. They are also used in a variety of molded parts for fuel systems (e.g., fuel rails and couplings) and other miscellaneous applications (e.g., brake lines). A major use in the automotive market is in air, brake, and fuel hoses. Nylon 12 may also be used for oil extraction pipes, household appliances, and sport items.

Following the economic slowdown in 2008, demand has improved for resins such as nylon 11, 12, 46, 610, and 612, polyarylamides, and nylon copolymers.

Demand for nylon 46, has increased significantly since the 1990s, prompting DSM, the world’s sole producer, to expand its plant in Geleen, Netherlands; DSM opened its third production unit in 2012. Nylon 46 has excellent mechanical properties and shows good resistance to temperature and solvents as a consequence of its high crystallinity.

Applications for nylon 46 include automotive parts, computers, mobile phones, and personal electronics. There is also growth in areas such as fine pitch connectors for liquid crystal displays, gears that include use in seat recliners and starter motors, and reflector packages for light-emitting diodes.

Nylon 46 in Japan is imported and marketed through DSM Engineering Plastics. Nylon 46 is sold for various injection-molded parts, films, and fibers. The resin reportedly shows good heat stability, impact strength, and reduced water absorption. Some promising uses are switches/connectors, which could replace nylon 66 in automotive parts.

Nylon 612 is used to a considerable extent for nontextile monofilament for the bristles of paintbrushes and toothbrushes. Of the three main types of nylon used in monofilament, nylon 66 has the highest crystallinity and tends to be used in applications requiring lighter gauges; nylon 6 is intermediate in crystallinity, while nylon 612, 610, and copolymers have the least crystallinity and are typically used in applications requiring heavier-gauge monofilament. Smaller amounts of nylons 69 and 610 are sold or used captively in specialty monofilaments.

Polyphthalamide is used in automotive applications such as motor end frames, emission control valve housings, transmission stub tubes, low-profile fog lamps, and water pump housings.

Small amounts of nylons 612 and 69 are also used in military wire because of their lower moisture absorption. Some nylon 12 is used in fiber optic applications.

Nylon MXD6 is used in automotive and electronic applications. A substantial amount of MXD® is fabricated into multilayer film that has better gas-barrier properties than nylon 6, especially at high humidity. Demand is expected to grow in food packaging applications for multilayer film comprised of nylon 6 and other films such as polyethylene or polypropylene.

Since semiaromatic nylon with terephthalic acid has superior heat resistance of 300°C or higher, applications are focused on electronic parts for use in surface mount technology (SMT) fabrication processes or automotive under-the-hood parts, which are subjected to high temperature. In automotive connectors, nylon 66 has been largely replaced with glass-reinforced PBT, which has lower moisture absorption and better dielectric properties; however, the new semiaromatic nylon is expected to make inroads because it is lighter in weight than PBT compounds.

Bio-based nylons

Bio-based nylons are similar in properties to conventional nylon, except they are produced using specialty bio-based monomers, rather than the conventional petroleum-derived monomers. They are gaining interest in the industry because they offer potential cost savings and production of the monomers allows reduced greenhouse gas emissions.

The following table lists producers that produce polymers or monomers (leading to nylon production) from renewable sources. Please note that most of these end products listed in the table are not completely derived from renewable resources; usually the monomer is derived from renewable resources and hence these products fall into the “bio” category.

Producers of bio-based monomers/nylons[a]

Company	Location	Products (bio-based)
Arkema	Changshu, China	Nylon 11
	Zhangjiagang, China	Nylon 10
BASF	Ludwigshafen, Germany	Nylon 610
BioAmber	Plymouth, MN, US	Monomer: bio-based adipic acid
Cathay Industrial Biotech	China	Nylon 66
Celexion	Cambridge, MA, US	Monomer: bio-based adipic acid
Draths/Amyris	Lansing, MI, US	Monomer: bio-based adipic acid
DSM	Herleen, Netherlands	Nylon 46, bio-based adipic acid
Evonik	Marl, Germany	Nylon 610, 612 and 1010, nylon 12
Genomatica	San Diego, CA, US	Monomer: bio-based adipic acid
Invista	"Multiple"	Nylon 610, nylon 612, nylon 1010
Mitsubishi Gas Chemical Company, Inc.	Belgium	Bio-based sebacic acid
Novozymes	Waltham, MA, US	Monomer: bio-based adipic acid
Rennovia	Menlo Park, CA, US	Monomer: bio-based adipic acid
Solvay	Saint-Fons, France	Nylon 610, nylon 1010, nylon 612
Toray	Japan	Nylon 6, nylon 66, nylon 610
Unitika Ltd.	Uji, Kyoto, Japan	Nylon resins: Product XecoT
Verdezyne	Carlsbad, CA, US	Monomer: bio-based adipic acid

a. Some of these end products listed in the table are not completely bio-based or derived completely from renewable resources.

Source: IHS Chemical estimates.

Bio-based nylon monomer and/or resin producers are located in the conventional nylon–producing regions of the world. However, the majority are located in the United States and Europe with some activity in China and Japan.

Arkema is the sole world manufacturer of nylon 11 and they use a route based on undecanoic acid, which is castor bean–derived and a monomer for the production of Arkema's Rilsan® nylon 11. Arkema's Rilsan® nylon 11 has been developed for natural gas transportation and distribution piping applications. These gas pipes are said to replace polyethylene (high density) and metal pipes. Rilsan® nylon 11 in gas pipes allows reduced methane emissions due to its great barrier properties compared to other plastics, lower installation costs and higher corrosion resistance, and can operate at higher pressures and temperatures than polyethylene pipe

Adipic acid is one of the two components used to manufacture nylon 66. The other component is hexamethylenediamine (HMDA). Nearly two-thirds of all the adipic acid made globally is consumed in nylon 66 production for textile fibers and as an engineering resin. Other end uses for adipic acid are in polyols used to make rigid and flexible foam polyurethane products (footwear, bedding, thermal insulation, furniture, auto seating), as a plasticizer component to produce flexible PVC used in wire and cable insulation, and for automotive interiors. Developers of bio-based chemical technologies believe that they will be able to create commercial-scale manufacturing technology to produce adipic acid competitively using nonfood agricultural feedstocks that are much lower in cost than hydrocarbon-based feedstocks.

Recently, start-up companies, such as Rennovia, Verdezyne, BioAmber, Celexion, and Genomatica, have developed bio-based routes to produce adipic acid, aiming at creating a 100% bio-based monomer for nylon; some have reached advanced pilot or demonstration scales. In October 2013, Rennovia shipped their first product samples to a potential customer.

The bio-based nylon resins are expected to be drop-in replacement for conventional nylons used in manufacturing an array of consumer goods, in medical applications, etc. Many new investments are being made in this sector including the bio-based nylon development deal signed by Ajinomoto and Toray Industries in 2012 for manufacturing 1,5-pentanediamine (1,5-PD), a raw material for nylons from plant sources.

The success of bio-based nylons versus conventionally produced nylons depends on the price competitiveness, economics of the raw materials, and production processes.

Introduction

Nylon resins are linear condensation polymers of high crystallinity with the repeating CONH link in the molecular chain. In nylon terminology, the numbers designate the number of carbon atoms between the amide groups. If two reactants contribute alternating chain segments, as is the case with polyamides based on diamines and dicarboxylic acids, the number of carbon atoms of the diamine is given first. Most commercial nylon polymers are based on aliphatic building blocks, nylon 6 and nylon 66 being the most important types of nylon resins. This report focuses on nylon resins used in plastics applications.

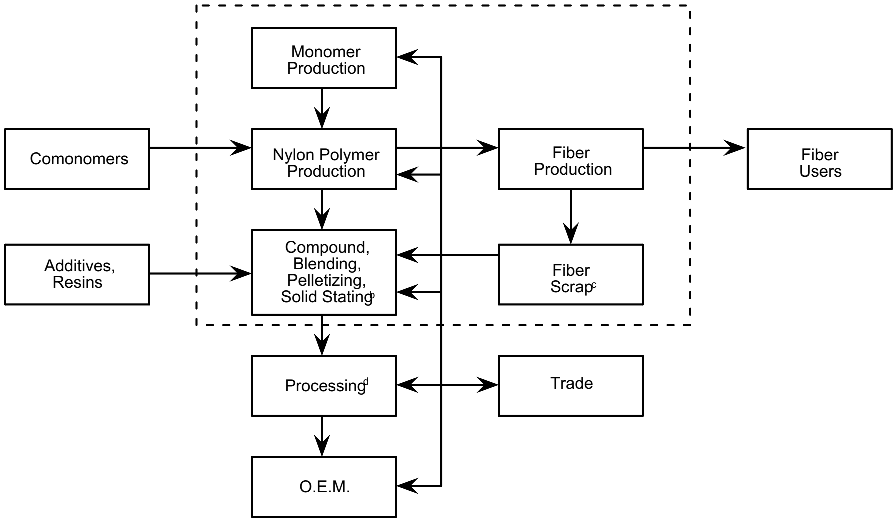
Nylon resins are primarily semicrystalline and typically classified under the grouping of medium temperature engineering thermoplastics. Other medium temperature engineering thermoplastics include polycarbonate, terephthalate polyesters, polyacetals, and polyphenylene ether (PPE)–based resins. Like other engineering thermoplastics, nylons are noted for their outstanding combination of properties, including high tensile strength; good resistance to creep; excellent abrasion resistance, chemical and heat resistance; and a low coefficient of friction. Nylon resins exhibit greater hardness than the polyolefins, yet they are fairly ductile and show a pronounced lack of brittleness. Hence, nylons have particular utility in performing a mechanical function that traditionally would have been performed by a metal part. Mechanical properties depend in detail on the degree and distribution of crystallinity, and may be varied by appropriate thermal treatment or by nucleation techniques. Nylon resin properties are usually modified by copolymerization and reinforcement of nylons, which results in increased properties, as explained throughout the report. Commercial introduction of nylon resins occurred at about the same time in the United States as in Western Europe—during the 1930s.

Nylon 6 and 66 have gained importance in Western Europe, Japan, and the United States over the years. Earlier, in Western Europe and Japan, caprolactam was the primary raw material initially used for nylon resin manufacture, to produce nylon 6. The market for nylon 66 developed first in North America.

The performance and processing characteristics of nylon resins can be tailored for niche markets in one or more of the following ways: controlling the molecular weight of the polymer, producing nylon copolymers, blending nylon with other resins to produce differentiated alloys, adding glass-fiber reinforcements and/or mineral fillers to increase mechanical properties, and incorporating other additives and modifiers (e.g., flame retardants, impact modifiers, and/or plasticizers) to produce compounds with a wide range of performance characteristics. The compounding of nylon molding resins by both main resin producers and non-resin producers (independent compounding producers) is an important element of the industry's structure.

The generalized structure of the nylon-resin business is summarized in the following diagram:

Materials flow/industry structure for nylon resins[a]



a. The largest resin producers are integrated from monomer to fully compounded product. Many also produce fiber. The smaller producers are generally not backward-integrated to monomer.

b. There are a number of independent compounders, including some that toll for resin producers.

c. Significant quantities of scrap fiber are used to manufacture engineering resins. Much of this scrap is post-industrial, but increasingly postconsumer streams are being recovered. Scrap nylon may also be chemically converted back to monomer but it is believed this will not be significant as long as scrap can be profitably used in engineering applications.

d. Major processing technologies include injection molding and extrusion/coextrusion.

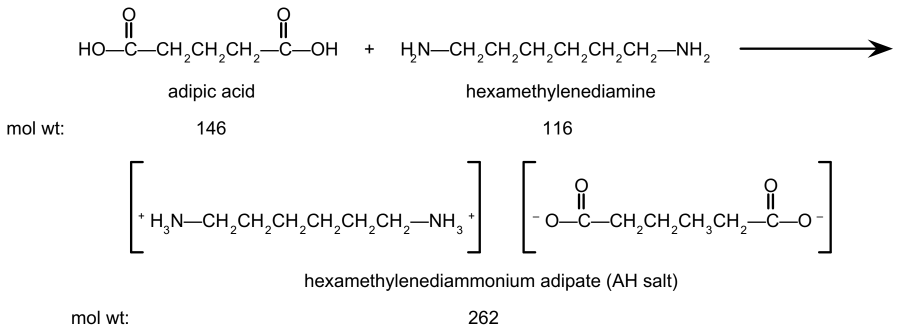
Since most engineering thermoplastics, including nylon resins, are converted to end products primarily through injection molding or extrusion, their melt-flow characteristics are an important factor in their comparative ease of use. In comparison to nylon 6, nylon 66 exhibits higher tensile strength and greater hardness and stiffness, but somewhat lower impact strength. Nylon 66 also has a higher melting point than nylon 6 and a higher heat deflection temperature. Nylon 6 has better surface appearance (particularly in glass-reinforced compounds) and flow characteristics and can be more easily colored/stained than nylon 66. The rate of water absorption of nylon 66 is somewhat lower than nylon 6, although relatively high moisture absorption is a characteristic of both nylon 66 and nylon 6. Absorbed moisture acts as a plasticizer and causes up to 6% dimensional changes that must be considered in design applications. Water absorption reduces dielectric strength somewhat limiting nylons use in electric insulating applications. In uses for which this water absorption is prohibitive (e.g., certain electrical, wire and cable coating applications) and greater flexibility is desired, nylons with a lower concentration of amide groups (e.g., nylons 612, 69, 610, 11, and 12) are used.

Several companies are actively involved in developing new processes for major nylon monomers, such as caprolactam and adipic acid (some major process variations have been developed but not commercialized). The effect of these developments, on a commercial level, would be an overall lowering of the cost to produce nylon, enhancing its competitiveness with other engineering resins.

Manufacturing processes

Nylon 66 resins

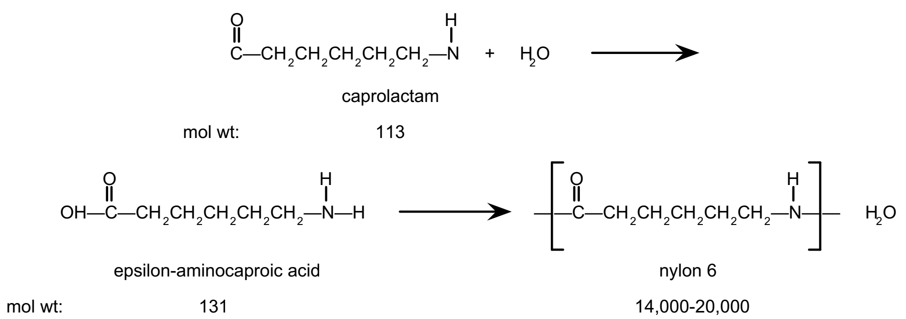
Adipic acid (derived from cyclohexane) and hexamethylenediamine (most commonly derived from butadiene or acrylonitrile) are prereacted to form nylon salt (AH salt) that is particularly well suited to purification. (The tolerances for impurities in the production of commercial nylon are very low.) The reaction is as follows:



Subsequently, the purified nylon salt is heated and, as water is removed, the polycondensation proceeds. The patent literature contains processes with many variations; current production units operate both continuously and by batch procedures.

Nylon 6 resins

Caprolactam (derived from cyclohexane or phenol) is reacted in the molten state with controlled amounts of water to obtain intermediate epsilon-aminocaproic acid, which readily condenses to the corresponding polyamide (nylon 6) as water is removed under controlled conditions of temperature and pressure.



The use of postindustrial nylon scrap has grown as a means of using relatively low-cost, high-performance materials for compounding feedstock. Regenerated fiber scrap will likely remain a major economic source of material for several major engineering nylon markets; the magnitude of use will depend more on availability and cost of recycling than on environmental pressures. Efforts to improve raw material efficiencies at fiber operations would reduce the availability of these materials.

In other aspects, current high demand for nylon resins may be influenced by other environmental issues. The flame retardant grades of nylon resins used in electrical applications have centered on brominated and chlorinated additives. Combustion of halogenated compounds can lead to the forming of dioxins, causing concern for the overall environment. Recently, many of these compounds have been or are in the processes of being phased out. There have been recent developments of halogen-free flame retardant grades of nylon and other engineering resins.

Environmental issues

Environmental issues have become a significant concern for many producers and consumers of plastic materials. Solid waste disposal and the potential to reduce disposal through recycling are the major aspects of this concern. Although much of the focus of waste reduction and recycling of plastic materials is centered on packaging materials—which include PET and polyolefins—recycling of nylon is also practiced and work is under way to broaden the range of materials recycled. Nylon, among others such as acrylonitrile-butadiene-styrene (ABS) and polycarbonate, are the leading engineering resins recycled.

Currently, much of the nylon recycled for engineering use is postindustrial waste or scrap materials that are by-products of nylon processing, especially the spinning of fibers. The value of this material is such that it is a misnomer to refer to it as waste; indeed, regenerated or scrap nylon is a major raw material for many nylon engineering uses and accounts for a substantial portion (believed in excess of 10% during some years) of all nylon engineering uses. Most of the major producers of nylon fibers and engineering resins use this by-product material to produce nylon compounds or sell it to compounders/users. Other postindustrial materials such as off-spec carpeting are also reprocessed into engineering uses. As more engineering resins, including nylon, are used in automobiles, interest in recycling these products will likely increase. In addition, the recycling of postconsumer carpeting is growing as reprocessing companies find effective ways to recover the value in the fiber. Among US automobile manufacturers, Ford is a leader in the promotion of recycled resin use and recycling of plastic automotive parts. As a current practice, most manufacturers are taking steps to incorporate more recycled nylon and other engineering plastics into their vehicle components.

The recycling of postconsumer nylon waste has become more widespread as efficient collection and improved separation technologies have been developed. Major nylon producers, as well as compounders—notably Wellman—also are recycling or have recycled carpeting materials. Wellman is an industry leader in innovative recycling. About 25% of the polymer feedstock for postconsumer resins is obtained from nylon carpets removed from offices and homes. It is believed that Entec Polymers, a distribution and compounding company, has a nylon postindustrial recycling resin plant at Manchester, Tennessee.

Nylon, like some other condensation polymers, can also be depolymerized to yield the original monomer(s). Research on depolymerizing nylon—especially that in carpeting—has been done by most major nylon fiber producers, and a major venture to depolymerize nylon 6 to yield caprolactam was commissioned in late 1999 by Evergreen Nylon Recycling, at the time, a joint venture of DSM and Honeywell at Augusta, Georgia (100 million pounds [45,360 metric tons] of caprolactam capacity). In mid-2001, DSM and Honeywell announced that they had independently suspended production at the Augusta plant citing poor market conditions and higher than expected production costs. The plant had been running at only 60% of capacity prior to shutdown. In 2006, Shaw Industries purchased the assets related to Evergreen Nylon Recycling, and in February 2007, the company started operations (operated by DSM Chemicals North America) after a six-year hiatus. Most, if not all, of the caprolactam produced by Evergreen Nylon Recycling is used internally by Shaw Industries.

The use of postindustrial nylon scrap has grown as a means of using relatively low-cost, high-performance materials in certain applications. Regenerated fiber scrap will likely remain a major economic source of material for several major engineering nylon markets; the magnitude of use will depend more on availability and cost of recycling than on environmental pressures. Efforts to improve raw material efficiencies at fiber operations would reduce the availability of these materials.

In other aspects, current high demand for nylon resins may be influenced by other environmental issues. The flame retardant grades of nylon resins used in electrical applications have centered on brominated and chlorinated additives. Halogenated compounds can, when pyrolyzed, form dioxins, causing concern for the overall environment. Recently, the most dioxin-prone compounds have been or are in the process of being completely phased out. There have been recent developments of halogen-free flame retardant grades of nylon and other engineering resins.

Government standards and regulations on fuel efficiency levels and safety in motor vehicles is another area of interest related to nylon resins (engineering plastics) and the environment. Fuel efficiency in automobiles is greatly enhanced by the replacement of metal and aluminum components with lighter weight and lower maintenance nylon resins. Lighter weight automobiles have a more positive impact on the environment in terms of fuel efficiency, CO_2 emissions, and greenhouse gases than do more metal-based motor vehicles.

Supply and demand by region

North America

The North American region produces both nylon 6 and nylon 66, with the latter being largest. More than 50% of the production is exported for both types of resins.

Production capacity

Fibers are produced directly from polymerization or from pelletized resin. Historically companies that produced nylon were all producing fibers and much of the polymerization capacity was built with fiber spinning as main off take. Resin pellets could be produced by diverting some polymer to pelletization. With the changing fiber demand and industry structure, integrated fiber production has been greatly reduced.

North American nylon 6 and nylon 66 resin capacity was about 743 thousand metric tons and 977 thousand metric tons, respectively, in 2015.

North American capacity for nylon 6
(thousands of metric tons)

	2013	2015	2020
United States	667	689	719
Canada	34	34	34
Mexico	20	20	20
Total	**721**	**743**	**773**

Source: IHS Chemical estimates.

Honeywell brought a new 40 thousand metric ton nylon 6 plant onstream in late 2015, raising the region's total nylon 6 capacity to 773 thousand metric tons in 2016.

The United States is the largest producing country within North America and contributes to about 93% of the total capacity of nylon 6 in the region in 2015. Similarly, the United States accounts for about 88% of the total capacity for nylon 66 in the region.

North American capacity for nylon 66
(thousands of metric tons)

	2013	2015	2020
United States	857	857	857
Canada	120	120	120
Mexico	-	-	-
Total	**977**	**977**	**977**

Source: IHS Chemical estimates.

The region is quite mature and stable in its production and no further changes in capacity are expected for either type of nylon resin, after the completion of Honeywell's nylon 6 plant expansion

Salient statistics

Nylon 6

The following table presents North American supply/demand for nylon 6:

North American supply/demand for nylon 6
(thousands of metric tons)

	Annual capacity	Operating rate (percent)	Production	Imports	Exports	Actual consumption
1990	218	126	274	24	8	100
1995	320	156	499	47	114	138
2000	477	118	564	80	206	124
2001	477	93	442	93	145	109
2002	553	92	510	108	200	105
2003	580	91	526	95	190	105
2004	579	95	551	133	207	99
2005	597	95	568	127	166	146
2006	597	95	569	132	174	153
2007	646	92	592	110	199	150
2008	688	85	582	68	213	135
2009	721	85	612	47	245	117
2010	721	89	640	72	272	138
2011	721	87	628	81	239	148
2012	721	76	549	100	180	165
2013	721	82	594	89	206	166
2014	733	80	587	95	201	170
2015	743	72	533	96	147	176

Source: IHS Chemical estimates.

In the last five years, North American nylon 6 capacity has increased at less than 1% per year.

The total capacity in North America of nylon 6 resin was about 743 thousand metric tons in 2015. However, production has been declining at about 3.6%, mostly due to the loss of export markets, which declined at about 12% per year between 2010 and 2015. Regional production was 533 thousand metric tons in 2015, leading to an operating rate of 72%.

In 2015, North America's total nylon 6 supply was 629 thousand metric tons; after trade, the region consumed 482 thousand metric tons, of which nylon 6 resins consumed 176 thousand metric tons or about 36% of the total.

Nylon 66

The following table presents North American supply/demand for nylon 66:

North American supply/demand for nylon 66
(thousands of metric tons)

	Annual capacity	Operating rate (percent)	Production	Imports	Exports	Actual consumption
1990	621	49	303	41	31	189
1995	661	59	388	49	63	242
2000	681	72	492	94	139	291
2001	681	74	502	100	165	285
2002	681	73	495	115	145	301
2003	681	72	492	123	152	297
2004	649	88	569	130	209	306
2005	662	81	534	137	223	264
2006	672	84	566	142	259	280
2007	722	83	601	130	306	268
2008	772	72	553	150	325	238
2009	773	54	414	127	195	189
2010	947	61	575	157	328	227
2011	977	70	688	133	404	244

North American supply/demand for nylon 66 (continued)
(thousands of metric tons)

	Annual capacity	Operating rate (percent)	Production	Imports	Exports	Actual consumption
2012	977	79	771	136	460	270
2013	977	82	799	157	513	281
2014	977	86	841	147	538	293
2015	977	86	840	159	553	301

Source: IHS Chemical estimates.

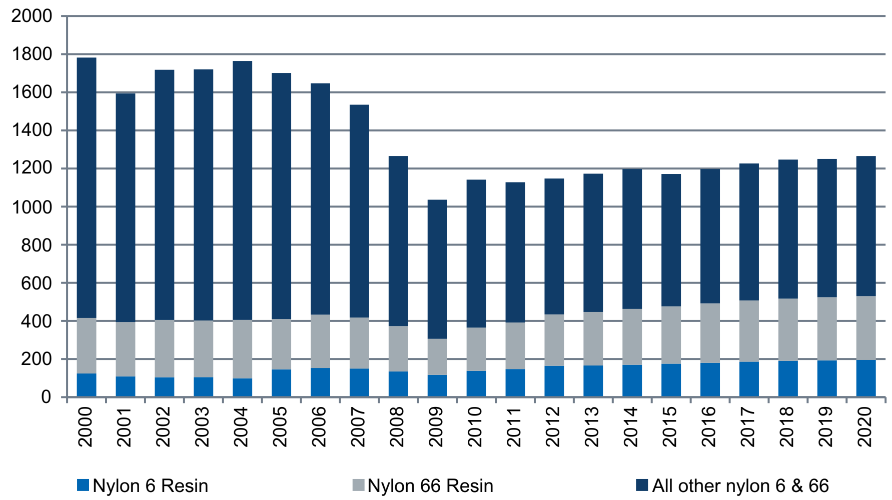
For the last five years, North American nylon 66 capacity has increased at less than 1% per year. The total capacity for nylon 66 resins is larger than nylon 6 in North America, at about 977 thousand metric tons in 2015. Regional production of nylon 66 in 2015 was 840 thousand metric tons, resulting in an operating rate of 86%. There are no capacity expansion announcements for nylon 66 resins in the region and operating rates are expected to remain at about 88% for the next five years.

In 2015, total nylon 66 supply reached 999 thousand metric tons; nylon 66 exports accounted for about 66% of North American production. After trade, North America consumed about 446 thousand metric tons of nylon 66, of which nylon resin applications consumed 301 thousand metric tons, or 67% of the total consumption in 2015.

Consumption

The following chart shows that about 1.2 million metric tons of nylon 6 and 66 were consumed in North America in 2015:

North American consumption of nylon by application

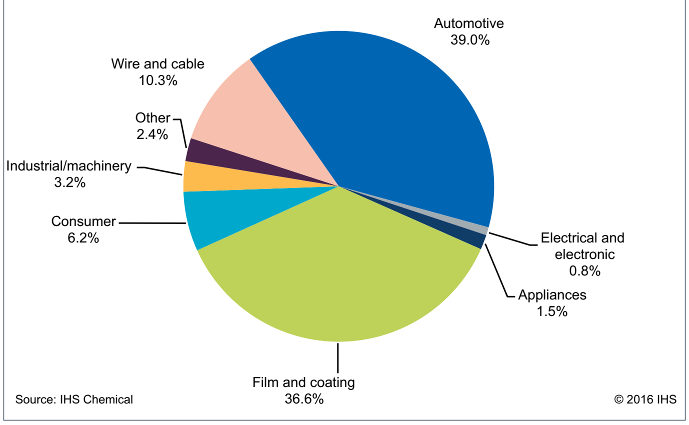


Notes: Data are in thousands of metric tons
Source: IHS Chemical

Nylon resin applications consumed about 40% of the total; the remainder was consumed in fiber applications. In the last five years, total consumption of nylon has been growing at about 0.5% per year; however, fiber applications have declined at a rate of 1.8% per year, while nylon resin applications have been growing at a faster rate of about 5.4% per year.

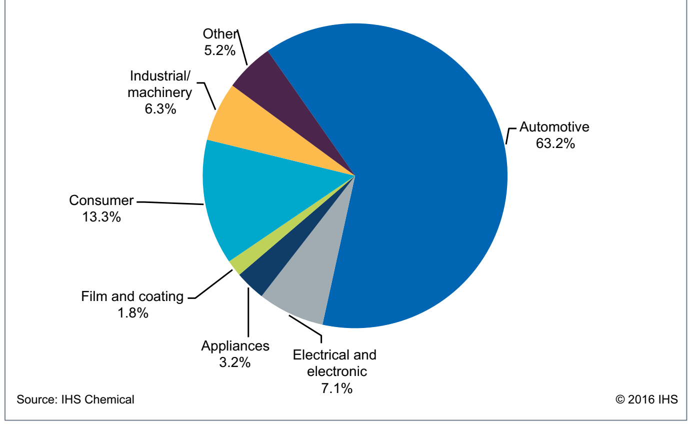
The following charts show the consumption of nylon resins by end use for nylon 6 and nylon 66. The main similarity between nylon 6 and nylon 66 resin consumption is that the automotive sector is the most important market segment. While film and coatings is a large application for nylon 6 resin, it is only a minor application for nylon 66.

North American consumption of nylon 6 by end use—2015



Source: IHS Chemical © 2016 IHS

North American consumption of nylon 66 by end use—2015



Source: IHS Chemical © 2016 IHS

The following table presents the North American consumption of nylon 6 resins:

North American consumption of nylon 6
(thousands of metric tons)

	Automotive	Electrical and electronic	Appliances	Film and coating	Wire and cable	Consumer	Industrial/ machinery	Other	Total
2005	45	2	1	57	23	9	6	3	146
2006	49	3	1	57	22	10	7	4	153
2007	50	2	1	56	20	11	7	3	150
2008	42	1	1	55	18	10	5	3	135
2009	33	1	1	54	13	8	4	3	117
2010	44	1	2	58	15	10	4	4	138
2011	50	1	2	60	15	11	5	4	148
2012	63	1	3	60	16	11	6	4	165
2013	64	1	3	62	17	11	5	4	166
2014	66	1	3	62	17	11	5	4	170
2015	68	1	3	64	18	11	6	4	176
2020	79	2	3	67	20	13	6	5	195
Average annual growth rate (percent)									
2015–20	3.1%	3.3%	3.8%	1.0%	1.6%	3.1%	2.7%	2.4%	2.1%

Source: IHS Chemical estimates. © 2016 IHS

The following table presents the North American consumption of nylon 66 resins:

North American consumption of nylon 66
(thousands of metric tons)

	Automotive	Electrical and electronic	Appliances	Film and coating	Wire and cable	Consumer	Industrial/ machinery	Other	Total
2005	158	20	9	5	-	37	19	16	264
2006	159	22	10	5	-	42	22	20	280
2007	152	22	8	5	-	41	22	18	268
2008	132	22	9	5	-	38	19	13	238
2009	104	17	7	4	-	30	16	11	189
2010	130	19	8	5	-	34	17	14	227
2011	144	20	8	5	-	35	17	14	244
2012	168	20	9	5	-	36	18	15	270
2013	176	20	9	5	-	38	18	15	281
2014	186	21	10	5	-	39	18	15	293
2015	190	21	10	5	-	40	19	16	301
2020	207	25	11	6	-	47	22	18	335
			Average annual growth rate (percent)						
2015–20	1.7%	3.2%	3.0%	1.3%	—	3.2%	2.7%	2.6%	2.2%

Source: IHS Chemical estimates.

In 2015, consumption of nylon resins in North America totaled 477 thousand metric tons, of which 63% was for nylon 66 resins and 37% was for nylon 6. The major markets are discussed below:

Automotive

North America produced about 18 million vehicles in 2015. In the last 10 years, vehicle production has increased at about 0.9% per year. However, recovery since the downturn in 2009, when production dropped to under 9 million vehicles, has been rapid, with vehicle production increasing at about 8.1% per year in 2010–15.

Automotive uses consumed about 258 thousand metric tons of nylon resins in 2015, with nylon 66 contributing 190 thousand metric tons or 74% of the total. Automotive applications represented a share of 54% of total nylon resins consumed in North America in 2015.

In the next five years, North American consumption of nylon resin for automotive uses is expected to grow at about 2.1% per year and reach about 286 thousand metric tons in 2020. Nylon 6 is expected to grow moderately faster than nylon 66.

Film and coating

Film and coating applications consumed more than 69 thousand metric tons of nylon resins in 2015. Nylon 6 accounts for about 93% of the consumption.

These applications are the second-largest market for nylon resins in North America and consumed about 14% of the total demand in 2015. In the next five years, film and coating applications are expected to grow at average rate of about 1.1% per year.

Consumer markets

Consumer applications consumed a total of about 51 thousand metric tons of nylon resins in 2015 and are expected to reach 60 thousand metric tons by 2020.

Nylon 66 accounts for about 78% of the nylon resin consumed in this application in North America in 2015. In the next five years, the consumption of nylon is expected to grow at about 3.3% per year.

Other

The remaining applications consumed about 99 thousand metric tons of nylon resin in 2015, with nylon 66 accounting for 66 thousand metric tons.

Trade

North America is a net exporter of both types of nylon resins. In 2015, the region exported 147 thousand metric tons and imported 96 thousand metric tons of nylon 6. Exports are expected to decline in the forecast period. The region imported 159 thousand metric tons and exported 553 thousand metric tons of nylon 66 in 2015. Imports are expected to grow in the forecast period. Intraregional trade accounted for about 180 thousand metric tons of nylon resin in 2105.

Overall trade in nylon resins will not undergo any major changes and will continue to trade similar volumes in the near future. The North American market production of nylons is geared toward export, but the region is expected to see a decline in overall export levels as Chinese consumption growth will be sourced more from local sources.

United States

United States has been the largest producer in North America and directs a large portion of production toward exports. The country is stable in its capacity and no new additions are expected in the short term.

Major producers also produce polymer for captive fiber spinning. Since scrap material from these processes is also used in engineering applications, operating practices in the fiber business can substantially influence effective engineering resin capacity.

Independent compounding companies produce nylon compounds from purchased virgin or scrap nylon (or both). Those that produce from scrap materials in effect add to the capacity to produce engineering nylon compounds.

Producing companies

The following table presents the US producers of nylon 6:

US producers of nylon 6
(thousands of metric tons)

Company	Plant location	Average annual capacity 2013	2015	2020	Raw material and process	Remarks
BASF Corp.	Freeport	270	270	270	N 6 continuous	
Beaulieu-Nylon	Bridgeport	38	38	38	N 6 continuous	
Cast Nylons	Willoughby	2	2	2	N 6 continuous	
Custom Resins	Henderson	12	12	12	N 6 continuous	
DSM Eng. Plastics	Augusta	60	60	60	N 6 continuous	
DuPont	Parkersburg	7	7	7	N 6 continuous	
EMS	Sumter	10	10	10	N 6 continuous	Copolymers and terpolymers.
Honeywell	Chesterfield	148	160	160	N 6 continuous	Converted BCF capacity.
	Chesterfield	0	10	40	N 6 continuous	Nylon 6 or copolymer nylon 6/66.
Nycoa	Manchester	7	7	7	N 6 continuous	From Nyltech.
	Manchester	5	5	5	N 6 autoclave	From Nyltech.
Polymer Corp.	Reading	3	3	3	N 6 continuous	Former DSM.
Shaw	Aiken	40	40	40	N 6 continuous	From Beaulieu.
	Clemson	25	25	25	N 6 continuous	From Honeywell.
	Columbia	40	40	40	N 6 continuous	Converted nylon staple.
Total		**667**	**689**	**719**		

Source: IHS Chemical estimates.

There are 11 producers of nylon 6 resins in the United States at 13 different locations/plants. There are no capacity additions expected in the next five years. The total nylon 6 polymerization capacity in the United States was about 712 thousand metric tons and the nylon 6 resin capacity was about 689 thousand metric tons in 2015. The difference between the nylon polymerization capacity and nylon resin capacity (about 23 thousand metric tons) can be attributed to the portion of nylon production that is integrated into direct production of fiber.

The largest producer of nylon 6 resins in the United States is BASF Corp. with a total nameplate capacity of 270 thousand metric tons, accounting for 39% of the capacity in the country.

Honeywell, with capacity of 170 thousand metric tons is the second-largest producer, although this will increase to 200 thousand metric tons once the 40 thousand metric ton expansion reaches full capacity in 2016.

The third-largest producer in the country is Shaw with a total capacity of 105 thousand metric tons at three locations. BASF, DSM, and Honeywell are all basic in caprolactam used for nylon 6.

The following table presents the US producers of nylon 66:

US producers of nylon 66
(thousands of metric tons)

Company	Plant location	Average annual capacity 2013	2015	2020	Raw material and process	Remarks
Ascend	Greenwood	90	90	90	N 66 continuous	Formally Solutia.
	Pensacola	410	410	410	N 66 continuous	Formally Solutia.
DuPont	Parkersburg	220	220	220	N 66 continuous	For plastics.
INVISTA	Chattanooga	65	65	65	N 66 continuous	From DuPont; most capacity used only for salt.
	Richmond	72	72	72	N 66 continuous	From DuPont.
Total		**857**	**857**	**857**		

Source: IHS Chemical estimates. © 2016 IHS

The total US nylon 66 resin capacity was about 857 thousand metric tons in 2015. There are a total of three producers of nylon 66 resins and five operating plants in the United States.

The largest producer is Ascend Performance Materials with a total nameplate capacity of 500 thousand metric tons in 2015. In 2010, Solutia's nylon business was acquired by SK Capital Partners and renamed Ascend Performance Materials. Total nylon 66 capacity reached 500 thousand metric tons in 2011, following the expansion of the Pensacola plant.

DuPont is the second-largest U.S. producer, with a nameplate capacity of 220 thousand metric tons.

In 2009, INVISTA's total capacity fell to 137 thousand metric tons after the 15 thousand metric ton nylon 66 plant in Seaford was shut down. Formerly DuPont's fiber business, INVISTA was sold to Koch Industries in 2004, along with nylon and polyester intermediates; the plants operate under the INVISTA name.

Ascend Performance Materials and INVISTA both manufacture HMDA and adipic acid for nylon 66 manufacture. INVISTA operates HMDA and adipic acid lines in Texas and Canada. Ascend supplies AH salt to a number of smaller producers for subsequent polymerization.

There are no announced capacity additions in the next five years.

Salient statistics

Nylon 6

The following table presents US supply/demand for nylon 6:

US supply/demand for nylon 6
(thousands of metric tons)

	Annual capacity	Operating rate (percent)	Production	Imports	Exports	Actual consumption
1990	164	114	187	-	-	70
1995	266	152	403	36	95	100
2000	418	122	510	65	191	95
2001	418	95	398	76	128	87
2002	494	94	464	85	176	82
2003	501	94	471	76	165	80
2004	525	95	497	100	173	69
2005	543	94	513	93	132	111
2006	543	95	516	97	145	113
2007	592	93	549	80	182	114
2008	634	86	543	41	195	105
2009	667	88	590	15	229	93
2010	667	93	621	21	253	101
2011	667	89	596	30	213	108
2012	667	76	508	46	151	114
2013	667	84	558	32	180	118
2014	679	81	553	30	170	121
2015	689	73	504	30	120	125

Source: IHS Chemical estimates. © 2016 IHS

In 2015, total US production of nylon 6 was 504 thousand metric tons at an operating rate of 73%. Once the Honeywell expansion is complete, operating rates are expected to slip slightly to around 69–71% range for the next five years.

In 2015, total supply of nylon 6 in the United States was 534 thousand metric tons; after trade the country consumed 414 thousand metric tons, of which 125 thousand metric tons, or 30% was consumed as nylon resins.

The US market for nylon 6 is quite mature and has stabilized, with no major changes expected in the future. The United States is one of the largest markets for nylon 6 production; in 2015, the United States was the fourth-largest producer in the world following China, Western Europe, and Taiwan.

Nylon 66

The following table presents US supply/demand for nylon 66:

US supply/demand for nylon 66
(thousands of metric tons)

	Annual capacity	Operating rate (percent)	Production	Imports	Exports	Actual consumption
1990	561	45	253	-	-	178
1995	561	55	310	10	50	205
2000	561	69	387	20	90	242
2001	561	73	412	11	132	223
2002	561	71	401	22	111	247
2003	561	72	403	29	125	240
2004	529	89	470	25	184	243
2005	542	83	450	22	207	194
2006	572	86	490	20	239	201
2007	622	83	517	25	272	202
2008	672	71	480	58	290	183
2009	673	49	331	55	169	140
2010	827	55	459	72	285	167
2011	857	68	584	45	366	180

US supply/demand for nylon 66 (continued)
(thousands of metric tons)

	Annual capacity	Operating rate (percent)	Production	Imports	Exports	Actual consumption
2012	857	76	655	45	416	198
2013	857	82	702	56	462	208
2014	857	86	741	50	484	217
2015	857	89	759	56	509	224

Source: IHS Chemical estimates.

The United States is a much bigger player in the nylon 66 market than in nylon 6, being the largest global producer. The total production in 2015 was about 759 thousand metric tons of nylon 66, at an operating rate of 89%.

About 67% of the production was exported in 2015; after trade, the United States consumed about 305 thousand metric tons of nylon 66. Nylon resin applications consumed 224 thousand metric tons or about 73% of the total nylon 66 consumed in 2015.

No capacity additions are expected in the next five years. Operating rates are expected to be in the range of 89–90% as the demand (both domestic and export) increases, raising production levels to about 767 thousand metric tons by 2020.

Consumption

The United States consumed about 937 thousand metric tons of nylon 6 and 66 in 2015. Nylon resin applications consumed about 37% of the total and the remainder was consumed in fiber applications. In the last five years, total consumption of nylon has grown at about 0.5% per year; in the next five years, total consumption is expected to grow at a 1.6% per year, although consumption of nylon in fiber applications are expected to decline.

The following table presents US consumption of nylon 6 resins by end use:

US consumption of nylon 6
(thousands of metric tons)

	Automotive	Electrical and electronic	Appliances	Film and coating	Wire and cable	Consumer	Industrial/ machinery	Other	Total
2005	26	1	-	48	21	9	5	1	111
2006	27	1	-	49	20	10	5	1	113
2007	29	1	-	48	18	11	6	1	114
2008	25	1	-	47	16	10	5	1	105
2009	20	1	-	47	12	8	4	1	93
2010	25	1	-	50	13	7	4	1	101
2011	28	1	-	52	13	8	5	1	108
2012	33	1	-	52	14	8	5	1	114
2013	35	1	-	53	15	8	5	1	118
2014	37	1	-	53	15	8	5	1	121
2015	38	1	-	55	16	8	6	1	125
2020	40	1	-	57	17	10	6	1	133
				Average annual growth rate (percent)					
2015–20	0.9%	3.1%	—	0.9%	1.7%	3.2%	2.7%	2.7%	1.3%

Source: IHS Chemical estimates.

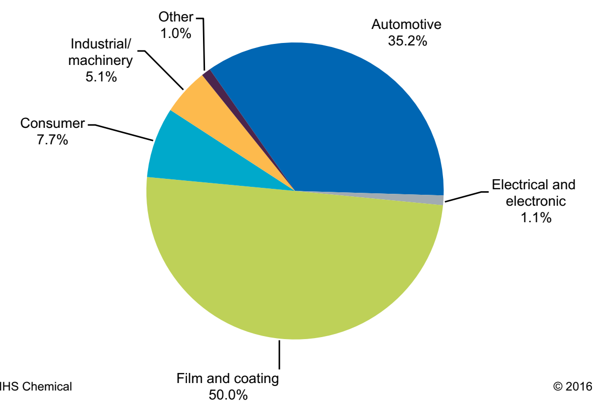
The following table presents US consumption of nylon 66 resins by end use:

US consumption of nylon 66 (thousands of metric tons)									
	Automotive	**Electrical and electronic**	**Appliances**	**Film and coating**	**Wire and cable**	**Consumer**	**Industrial/ machinery**	**Other**	**Total**
2005	107	17	6	4	-	34	14	12	194
2006	105	18	6	4	-	38	16	14	201
2007	102	19	6	4	-	39	18	14	202
2008	90	19	7	4	-	37	16	10	183
2009	70	14	5	3	-	28	13	7	140
2010	87	15	6	4	-	31	14	10	167
2011	97	16	6	4	-	32	14	10	180
2012	114	16	6	4	-	33	15	10	198
2013	123	16	7	4	-	33	15	11	208
2014	129	16	7	4	-	34	15	11	217
2015	133	17	7	4	-	36	16	11	224
2020	140	20	8	4	-	42	18	13	244
			Average annual growth rate (percent)						
2015–20	0.9%	3.1%	2.7%	1.1%	—	3.2%	2.7%	2.7%	1.7%

Source: IHS Chemical estimates. © 2016 IHS

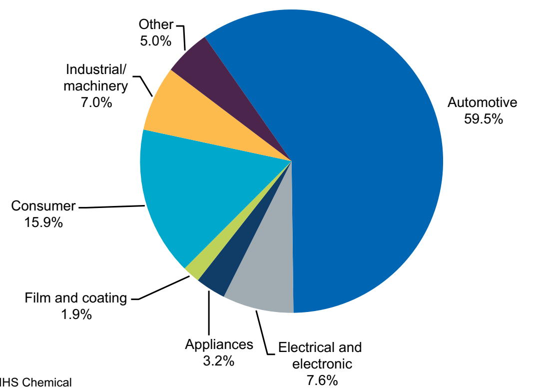
The following charts show the consumption of nylon resin by end-use for nylon 6 and nylon 66:

US consumption of nylon 6 by end use—2015



Source: IHS Chemical © 2016 IHS

US consumption of nylon 66 by end use—2015



Source: IHS Chemical © 2016 IHS

The consumption of nylon 66 is dominated by the automotive applications in the United States, while film and coating consumes the largest proportion of nylon 6.

Although nylon was invented over 80 years ago, product development aimed at enhanced performance has extended its life cycle. Innovations in filled and reinforced nylon technologies, as well as alloying, have been sustaining growth in recent years. Growth has also been assisted by increased use of reprocessed nylon fiber scrap in nylon resins, which has extended the economical range of the nylon resin business, allowing competition with lower-priced performance plastics.

An examination of the consumption of nylon resins shows that nylon has historically grown at about twice the rate of general economic growth; reasonable estimates of nylon consumption could be deduced from forecasts of gross domestic product.

In the 1990s, growth was even more vigorous—an era when GNP growth was more robust than usual, as well. During the 2000s, however, nylon resin markets were plagued by recessions in 2001, 2004, and 2008, limiting continued growth. As a result, it is estimated that future nylon resin growth will most likely retain a closer relationship with growth in its largest sector, the automotive market. The demand for nylon resins in the United States is forecast to grow at a rate of 1.6% for the next five years.

Automotive

In 2015, the United States produced about 12.2 million vehicles, accounting for more than two-thirds of North American production and about 13.4% of the total vehicle production in the world. The total nylon consumed in this application is about 171 thousand metric tons, with nylon 66 accounting for 78% of the total. In the next five years, US vehicle production is forecast to grow at about 0.8% per year and demand for nylon resin automotive uses is expected to grow at around 1% per year, to reach 180 thousand metric tons by 2020.

Automotive applications are the main driver of the nylon resin consumption, representing about 49% of the total consumption in 2015. The US automotive industry is more inclined to use nylon 66 for under-the-hood automotive applications that require high temperature performance and resistance to automotive fluids.

The automotive market is the largest market for nylon molding resin compounds. In recent years, much of the growth in nylon resin consumption has come from this market, which has been driven by new under-the-hood applications such as oil modules, engine pans, covers, manifolds, fan blades, and emission control canisters.

Automotive applications have proliferated in recent years for many plastics as a result of the general trend toward replacing metal parts with plastics, primarily to reduce the overall weight of motor vehicles and improve fuel economy, but also to produce complex parts economically.

Major segments of the automotive market and primary applications for nylon include the following:

- **Body.** Exterior mirror housings, exterior door handles, window lift mechanism, grille/headlamp support, rear end panels, interior handles or window latches, body pillar reinforcements

- **Interior.** HVAC vents, gear shifter housings, airbag housings, interior steering column housings, interior speedometer components

- **Powertrain and chassis.** Brake fluid reservoirs, fuel vapor canisters, fuel lines, pedal modules, transmission filter housings, wheel covers, windshield wiper components/tubing, wiring harnesses, connectors, switches/sockets, fuse/junction systems, air intake manifolds, turbo ducts

- **Underhood/engine.** Intake manifolds, air cleaners, radiator-fan shields, radiator-end tanks, radiator fans, air conditioner fans, coolant system heater core ends, vacuum systems, power steering reservoirs, engine control systems, engine oil pans, engine timing belts/torque chains, engine camshafts

Applications consuming the largest amount of nylon include exterior mirror housings, fuel vapor canisters, transmission components, switches/sockets, intake manifolds, air cleaners, radiator-fan shrouds and end tanks, and canisters.

The increased use of nylon resins in automotive applications can be attributed to the material's performance capabilities. For example, body components molded from mineral-filled nylon and some nylon alloys (PPE/nylon) can withstand paint-oven exposure on the assembly line. Nylon's high level of rigidity and adequate impact strength have been improved and complemented with good dimensional stability through blending with elastomers and/or glass and mineral reinforcements.

Whereas small components accounted for most nylon use in this market in the past, large parts, such as engine intake manifolds, have appeared on more models in recent years. Nylon 66 resin once accounted for the majority of these applications because of its higher temperature stability, although there are some applications with less severe temperature exposure where reinforced nylons 6 and 66 are interchangeable. The wear performance of nylon 6 favors its use in some applications as well. Other nylon applications that have recently received approval are use in truck tire regulators, exhaust system parts (Zytel®), and fuel tank sensors (Ultramid®), as they are inert to gasoline and other compounds (such as methanol, ethanol, and zinc chloride). Some applications requiring higher temperatures may require polyphthalamides such as Amodel® or nylon 4/6 Stanyl®.

The growth of nylon resins in the automotive industry during the next few years will depend on several factors, as follows:

- Domestic production levels for all automobiles
- The mix of motor vehicle types (model, size, make)
- Development of resins and new processes to allow further penetration by nylon parts
- Competition with alternative lower-cost plastics, particularly glass-filled polypropylene and recycled materials

Film and coating

Film and coating applications consumed about 59 thousand metric tons of nylon resins in 2015, accounting for about 17% of the total consumption. About 55 thousand metric tons of nylon 6 and 4 thousands metric tons of nylon 66 were used in these applications. Film and coating applications are expected to grow at an average rate of 0.7% per year for the next five years.

Nylon film is a broad term that includes stand-alone monolayer films as well as components of multilayer composites (laminations and coextrusions) and extrusion coatings. Composites can be produced by laminating nylon film to other film or foil layers, by coextruding nylon resin with other plastic materials, and by extrusion or roll coating a substrate with a particular nylon resin. A major reason for using composites structures is to enhance barrier and sealing properties in flexible packaging applications. Examples of other materials used include aluminum foil, ethylene–vinyl alcohol (EVOH), polyvinylidene chloride (PVdC), and polyethylene homopolymers and copolymers (LLDPE, LDPE).

More than 93% of the nylon resin that is used for film applications is nylon 6. Other nylons, including nylon 66, nylon 66/6 copolymers (triple 6), and other types are used to a much lesser extent. The selection of a particular resin is dependent on its processing parameters (melt temperature) and performance properties (barrier properties and toughness).

Nylon film is used primarily in food packaging. Regardless of the use, there are three major forms that nylon films may take—nonoriented or unidirectionally oriented films, biaxially oriented films (BOPA), and coextruded films. Extrusion coating of board is a small but growing use for nylon.

There are three basic processes for BOPA film—simultaneous, two-step tenter, and double bubble. All three processes were developed in Japan by Japanese companies that are the licensors of these processes and technologies. Unoriented or uniaxially oriented films are produced either with cast systems or blown systems, the latter usually producing a film with better strength and barrier properties. Honeywell and American Biaxis (Canada) are the major producers of BOPA film in North America. Imports from Japan are also a significant source of BOPA film.

Using nylon resin as a layer in a coextruded film is also a major outlet for nylon; both cast and blown systems are capable of producing such coextrusions. Thick film structures (forming webs) may also be converted by thermoforming to provide packaging for such products as luncheon meats and medical products and components. Film manufacturers are increasingly gaining the capability to produce films with greater numbers of layers. As this trend continues, opportunities to use nylon increase, albeit with thinner layers.

Packaging accounts for much nylon used in films, especially BOPA and coextrusions. Food is the most important product packaged in terms of weight, but medical and pharmaceutical products are increasing in importance, as people are living longer. Nylon is relatively expensive compared with most other resins used for packaging films, but its barrier to aromas, fats, and oxygen combined with its toughness, sealability, and printability warrant its use for a number of higher-value products. Processed fresh foods such as meats, cheeses, and liquid packaging (bag-in-box pouches) are major food markets for BOPA film. Book covers and balloons are major nonfood items.

Major producers of nylon-containing coextruded films and extrusion and/or BOPA nylon film structures include American Biaxis, Honeywell, Printpack Inc., Alcan Packaging, Curwood (Bemis Polyethylene Packaging Division), Cryovac division of Sealed Air Corporation, Scholle Corporation (bag-in-box), General Binding Corporation (book covers; an ACCO Brands Company), and Anagram/M&D (balloons).

Other markets for nylon films, some of it nylon 66, are carrier webs for sheet molding compound (SMC) and fiberglass-reinforced plastic panels (FPP), and vacuum bag molding of composites for the aircraft/aerospace industry.

The dominant trend in nylon films is the growing acceptance of BOPA and coextruded multilayer films containing nylon as strength or barrier resin or both. Nonoriented and uniaxially oriented nylon films are expected to decline because of escalating competition from lower-priced PET films.

Demand for higher-barrier nylons in flexible packaging markets has increased as food companies are requiring a longer shelf life for most, if not all packaged foods. Amorphous nylons are being used in blends with semicrystalline nylon 6 to improve the oxygen barrier properties by over 60% at 85% relative humidity. Improvements in the optics, surface glass and thermoforming properties of nylon 6 are also achieved by blending it with amorphous nylon. The variety of nylon grades available includes not only the old standby grades but whole new families of compounds designed for a large variety of specific end uses. New grades continue to be offered to challenge other thermoplastics in a wide variety of applications.

Over the next five years, consumption for filament coating is expected to grow at 0.9% per year. Strong growth is anticipated in nanocomposite-containing barrier nylon structures. Currently this is a small but growing market due to increased barrier properties and decreased structure weight (see **Mineral-filled nylons** in the **Appendix I**).

Consumer goods

Consumer goods had a demand of about 44 thousand metric tons of nylon resins, with 36 thousand metric tons of nylon 66 and 8 thousand metric tons of nylon 6 in 2015. This application accounted for about 13% of the total demand in 2015 and will have an average growth rate of 3.4% per year for the next five years.

Consumer articles that are injection molded from nylon resins include valves for aerosol cans, and parts and components for recreational items (bike wheels, toys, in-line roller skates, ice skates, ski boots, marine deck fittings, golf club parts, and gun stocks). Examples of other nylon consumer items are cigarette lighter bodies, spatulas, and personal care articles (brush backings, combs).

Nylon 66 resins account for the majority of nylon consumed in this market (roughly 82% in 2015), but nylon 6 and smaller amounts of specialty nylons are also used. Significant amounts of polyacetal are also used in various consumer articles such as cigarette lighters. Annual growth of about 3.4% per year projected in this market during the next five years, including higher-than-average growth in recreational-type items.

Nontextile monofilament is for the bristles of paintbrushes and toothbrushes (for which nylon 612 is used to a considerable extent). DuPont Filaments is a prominent producer of nylon bristle stock and other nontextile nylon monofilaments for cosmetic brushes to toothbrushes, industrial brushes to paintbrushes (containing nylon 6 and 612). In applications such as paintbrush bristles, polyester monofilament is preferred for latex paints, while nylon bristles are usually best for oil-based paints. Other major applications for nylon monofilaments include weed trimmer whips and woven support structures used in the production of paper (fourdrinier screens). Additional examples of consumer-related uses are coil zippers, waistband stiffeners for men's trousers, and fishing line. (Some of these latter applications are also covered in the CEH *Nylon Fibers* report.) Of the three main types of nylon used in monofilament, nylon 66 has the highest crystallinity and tends to be used in applications requiring lighter gauges; nylon 6 is intermediate in crystallinity, while nylon 612, 610, and copolymers have the least crystallinity and are typically used in applications requiring heavier-gauge monofilament. Smaller amounts of nylons 69 and 610 are sold or used captively in specialty monofilaments. During the 1980s the commercialization of weed trimmers provided a high-growth opportunity for nylon monofilament. During 2001–02 and again in 2008–09, this consumer market suffered from economic downturns. Over the next few years, growth is expected to improve slowly as the market is considered to be mature.

Industrial and machinery

Industrial and machinery applications consumed about 22 thousand metric tons of nylon resins in 2015, with nylon 66 accounting for about 73% of the total. These applications consumed 6.3% of the US nylon resin market in 2015. During the next five years, growth for nylon resins in this application will average about 1.8% per year.

Industrial/machinery components and parts that are injection molded from nylon resins represent a very fragmented market. Growth in this market had been rapid from 1980–2003 but has slowed over the past decade. Nylon 6 does well in these markets where, compared with other markets, slightly less performance and lower cost drives demand. Nylon 6 is also favored for its superior moldability/aesthetics for appearance parts.

Parts for small gasoline engines (e.g., lawn mowers, snowmobiles, chain saws, portable generators, and outboard motors) account for a substantial portion of total demand. Power tool and lawn mower/snowmobile housings are included in this category. Nylon is used in these applications because of its excellent resistance to gasoline and petroleum products in addition to its high-temperature resistance. Substantial amounts of reinforced nylon 6 are used in this segment as well. Typical parts include starter gears, air silencers, carburetors, cooling air directors, oil caps, shrouds, and housings. In more recent years, growth in this segment has been high because nylon, offering reduced costs, has replaced metals such as zinc and magnesium.

Small parts for other industrial equipment constitutes another market segment, in which cams, roller bearings, small gears, sprockets, pulleys, bushings, and fan blades exemplify the large variety of injection-molded nylon articles used. In this segment, nylon competes with polyacetal resins, terephthalate polyester resins, and PC/PBT alloys; nylon consumption in these products is expected to continue to grow moderately over the next five years.

Nylon is also used in fluid management applications such as impellers, valves, and pump parts. Other plastics that compete in this area include polypropylene, PPE/HIPS alloys, and fluoropolymers.

Electrical and electronic

Electrical and electronic applications consumed about 18 thousand metric tons, more than 5% of the total demand in 2015. These applications of nylon resins are expected to grow at 3.1% per year in the next five years. About 94% of all nylon resins consumed for electrical and electronic applications is nylon 66.

There are three large segments in the electrical/electronic market. One segment includes primarily “male-female”-type electrical connectors that supply power to equipment such as computers. Some glass-reinforced nylon 612 is consumed in premium electrical connectors. A second segment involves primarily wire and cable ties that are used for bundling electrical wires and cables, as well as various clips, fasteners, and wire guiding devices. This market is mainly lower-priced nylon 66 resin.

The third segment comprises a wide variety of components, including coil forms, battery boxes, small motor casings, relay covers, switch plates and housings, fuse holders, terminal blocks, grommets, plugs, and clips. Electrical and electronic applications for automotive uses are included in this category.

Nylon has traditionally been used in electrical parts because of its toughness, insulating ability, and fire retardance. In electronic applications, polybutylene terephthalate (PBT) resins compete for share in the connector market on the basis of its better electrical resistance, lower moisture absorption, better dimensional stability, and because they are more easily modified to meet fire-retardance requirements. Nevertheless, nylon is still desirable as a connector material for tough-service applications and its use is believed to be growing at rates similar to those for PBT. Polyphthalamide’s high heat deflection temperature, which provides resistance to infrared vapor-phase soldering temperatures, has led to applications such as light-emitting diode housings and assembly housings for surface-mount, right-angle circuit board indicators. Other polyphthalamide molding applications include subminiature DIP switches and connectors. Imported nylon 46 is also growing in this market and is competing with liquid crystal polymers and PPA.

Wire and cable

Wire and cable applications consumed nearly 16 thousand metric tons of nylon 6 in 2015 and is expected to grow at about 1.7% per year in the next five years. The application of nylon resins in wire and cable end uses is about 5% of the entire demand in 2015.

Extrusion wire and cable applications for nylon are based primarily on nylon 6. In this market, heat-stabilized nylon 6 is generally used as a protective layer over PVC primary insulation on wires carrying 120–240 volts. Principal applications are for industrial and residential building wires/cables that conform to certain specifications of the National Electric Code (National Fire Protection Association-NFPA). When used in hospitals, shopping centers, and other commercial buildings, the abrasion-resistant nylon coating (typically 4 mil in thickness) provides protection for the wire as it is pulled through ducts and/or conduit during installation. In residential applications, nylon jacketing is used in "NM" cable, which conforms to the higher in-use temperature requirements (90°C) set forth in the 1984 National Electric Code. In this application, a thin outer layer of nylon over a thin layer of PVC has been used to replace thick sections of PVC, producing lighter-weight cables that are both easier to handle and less expensive to install. Small amounts of polybutylene terephthalate (PBT) resins are also used in this application.

The high growth opportunities that were created for nylon by changes in the National Electric Code resulted in an average annual growth rate of approximately 11% during 1988–99 for all nylon resins used in wire and cable insulation. Nylon wire and cable insulation remains a smaller consumption market.

Appliances

Appliances consumed about 7 thousand metric tons of nylon 66 resins in 2015, or about 2% of the total consumption. This market includes major home appliances (refrigerators, ranges, freezers, dryers, and dishwashers), as well as small appliances such as personal care items and irons, ice crushers, smoke detectors, blenders, and can openers. Illustrative of nylon appliance components and parts are electric knife blade holders, sewing machine cams, and various small parts for large appliances such as feet and motor supports. Polyphthalamide (PPA) has been fabricated into vacuum cleaner impellers and in brush holders and drive train gears for electric drills. Polyacetal resins are also used in appliance parts. Annual growth of about 2.7% is expected in this market over the next five years.

Other

Other uses for nylon resins include a variety of small molded products, including hardware and furniture parts, as well as stock shapes, bottles, and products made using other processing techniques. This market consumed more than 12 thousand metric tons of nylon in 2015.

Plastic fasteners have traditionally been made from nylon because of nylon's toughness and strength. Most fasteners are made from nylon 6, although less expensive resins such as ABS or polypropylene are also used to mold fasteners. These fasteners are used where chemical resistance, nonmagnetic properties, and/or special sealing or locking characteristics are required. The same type of fastener that is used for hardware and furniture parts is commonly used in other markets as well.

Nylon resin is also used in small molded parts for drapery and window hardware, as well as furniture, fixture, and door hardware. Frequently, these applications involve small rollers (in the suspension mechanism of file cabinet drawers and for sliding doors), lock parts, trim strips, bumper strips, and slide strips. In many of these applications, nylon competes with polyacetal; polyacetal is often preferred for sliding parts because of its wear resistance. There are still opportunities for nylon resin to replace metal in some areas. Design innovations in furniture hardware (casters) also offer growth opportunities for nylon over the next five years. Annual growth of 3.1% is expected in this market over the next five years.

Other articles that can be identified in the other molded parts category are components of laboratory and medical equipment and military items (helmet liners and dummy rifle bullets). Also included in this category is use of nylon in various building and construction applications. Rotomolded tanks are included in this category as well.

Some nylon resins are extruded into stock shapes that are subsequently used for machining into precision parts that are difficult to mold. Approximately 5 thousand metric tons of nylon resins were consumed in stock shapes, strapping, and other forms in 2015. These products are usually made of nylon 66 resin and they compete with nylon 6 parts, which are produced by casting.

Some nylon resins are processed by such techniques as rotomolding, blow molding, and continuously reinforced composites. Rotomolded nylon 6 is used in such applications as military fuel tanks, hydraulic tanks, under-the-hood ducting in trucks, and blower housings. Blow-molded products include fluid reservoirs and radiator overflow tanks in automobiles and specialized packaging applications. This processing application, although practiced for decades, is still in early commercial development and is believed primarily to utilize the intermittent extrusion blow-molding process. Use may expand into other markets, but nylon faces competition from other engineering resins. Nylon extrusions or coextrusions can also be thermoformed. These uses are included in the film and coating section.

A potential market for nylon is barrier plastic bottles, especially for beer (an oxygen-sensitive beverage). An increasing use of plastic over glass in beer bottles has developed over the past decade despite obstacles such as barrier properties of plastic and economics. One method of producing a bottle that has sufficient barrier is to coextrude polyethylene terephthalate (PET) and nylon. Barrier coating technologies provide the longest carbonation shelf life and good oxygen barrier characteristics, whereas the active multilayer bottle offers manufacturing flexibility and outstanding oxygen barrier performance, but a shorter carbonation shelf life. Despite these shortcomings, beer bottlers will continue to offer beer in alternative packaging during the next several years.

Nylon products can also be manufactured directly from monomers in the mold. This is accomplished by mixing two streams containing various monomer (and/or prepolymer), catalysts, activators, and other additives just prior to filling the mold. The two most important types of monomer processing are reaction injection molding (RIM) and casting (not to be confused with cast films). DSM is active in this type of processing in Europe. Monomer processing is often used to produce very large parts and can also be used to produce stock shapes for milling into various other forms. Caprolactam is usually used, yielding a nylon 6 form, but nylon 6/12 and 12 can also be produced this way. See the CEH *Caprolactam* report for additional information about monomer processing.

Growth for these processes and applications will be varied, depending on how much developmental effort is expended in the near future. Overall consumption of nylon in this area is forecast to reach 14 thousand metric tons by 2020.

Trade

US government trade data does not segregate the nylon by type and includes nylon chip that is imported for the manufacture of fibers, as well as engineering products and a significant quantity of specialty nylons, including nylons 46, 11, 12, and polyphthalamide, sourced from Europe and Japan.

Several factors influence the levels of imports. These include currency fluctuations and trade policies of exporting countries and product slates of global manufacturers. Since many producers are global, they have the freedom to manufacture where economics are most favorable. Global manufacturers also may produce certain resins in selected geographies and ship polymer to other regions for compounding to complement their domestic production. It is believed that most of the resins imported—at least from other continents — are uncompounded polymer.

The United States is a net exporter of both of nylon 6 and 66 resins. In 2015, the United States imported 30 thousand metric tons and exported 120 thousand metric tons of nylon 6. In 2015, the United States imported 56 thousand metric tons and exported 509 thousand metric tons of nylon 66.

The main destinations for US nylon resin exports are Northeast Asia (40%) and Southeast Asia (17%). Mexico and Canada account for about 25% of the nylon resin exported from the United States.

Canada

Canada produces both types of nylon 6 and 66 engineering resins and is a net exporter of nylons.

Producing companies

There are two producers of nylon 6 and one producer of nylon 66 in Canada.

The following table lists nylon 6 producers, their plant locations and average capacities in Canada:

Canadian producers of nylon 6
(thousands of metric tons)

Company	Plant location	Average annual capacity 2013	2015	2020	Raw material and and process	Remarks
Firestone Fiber	Woodstock	9	9	9	N 6 continuous	
Nylene Holdings	Arnprior	25	25	25	N 6 continuous	From Honeywell.
Total		**34**	**34**	**34**		

Source: IHS Chemical estimates. © 2016 IHS

The following table lists nylon 66 producers, their plant locations, and average capacities in Canada:

Canadian producers of nylon 66
(thousands of metric tons)

Company	Plant location	Average annual capacity 2013	2015	2020	Raw material and process	Remarks
INVISTA	Kingston	120	120	120	N 66 continuous	From DuPont Canada.
Total		**120**	**120**	**120**		

Source: IHS Chemical estimates. © 2016 IHS

The total nylon 6 resin capacity in Canada was about 34 thousand metric tons in 2015. The nylon 66 resin capacity was about 120 thousand metric tons. There has not been any major change in capacity over the past decade and no major capacity additions are anticipated in the next five years.

INVISTA is the only producer of nylon 66 in Canada with two plants located in Kingston, Ontario with a total annual capacity of about 120 thousand metric tons. Nylene Holdings has capacity of about 25 thousand metric tons of nylon 6 at a plant located in Arnprior, Ontario. The other producer of nylon 6 is Firestone Fiber with a small 9 thousand metric ton plant in Woodstock, Ontario.

The principal markets for Canada's engineering plastics are for the automotive, electrical, and consumer goods industries.

Salient statistics

Nylon 6

The following table presents Canada's supply/demand for nylon 6:

Canadian supply/demand for nylon 6
(thousands of metric tons)

	Annual capacity	Operating rate (percent)	Production	Imports	Exports	Actual consumption
1990	9	167	15	24	8	18
1995	9	322	29	11	13	13
2000	14	229	32	15	14	13
2001	14	229	32	14	16	11
2002	14	229	32	18	17	13
2003	34	94	32	17	14	15
2004	34	100	34	25	23	17
2005	34	106	36	33	34	19
2006	34	97	33	28	28	18

Canadian supply/demand for nylon 6 (continued)
(thousands of metric tons)

	Annual capacity	Operating rate (percent)	Production	Imports	Exports	Actual consumption
2007	34	85	29	21	16	18
2008	34	79	27	21	18	16
2009	34	36	12	22	11	12
2010	34	23	8	28	12	15
2011	34	61	21	27	20	16
2012	34	76	26	25	24	17
2013	34	65	22	28	21	17
2014	34	62	21	33	24	17
2015	34	56	19	29	19	17

Source: IHS Chemical estimates. © 2016 IHS

Production was about 19 thousand metric tons at an operating rate of 56% in 2015. With no expected increase in demand for nylon 6 for fiber or nylon resin applications, Canada is expected to maintain its production but reduce exports. In 2015, engineering application consumed 17 thousand metric tons or about 57% of the nylon 6 consumed.

Nylon 66

The following table presents Canada's supply/demand for nylon 66:

Canadian supply/demand for nylon 66
(thousands of metric tons)

	Annual capacity	Operating rate (percent)	Production	Imports	Exports	Actual consumption
1990	60	83	50	41	31	12
1995	100	78	78	23	13	38
2000	120	88	105	46	49	38
2001	120	75	90	45	33	41
2002	120	78	94	43	34	37
2003	120	74	89	45	27	38
2004	120	83	99	42	25	37
2005	120	70	84	49	12	41
2006	100	76	76	47	15	39
2007	100	84	84	43	28	33
2008	100	73	73	39	28	29
2009	100	83	83	27	26	21
2010	120	97	116	32	43	24
2011	120	87	104	36	38	26
2012	120	96	116	35	43	29
2013	120	81	97	42	52	29
2014	120	83	100	34	54	29
2015	120	68	82	39	44	28

Source: IHS Chemical estimates. © 2016 IHS

In the last five years, Canadian production of nylon 66 has declined about 6.8% per year, reaching 82 thousand metric tons in 2015 for an operating rate of 68% of capacity. Canada's exports accounted for about 54% of production in 2015, but with imports, consumption was about 77 thousand metric tons in all nylon 66 applications. In the past five years, consumption has grown at about 3.1% per year, with nylon resin applications gaining share. In 2015, nylon resins consumed 28 thousand metric tons or 36% of the total nylon 66 consumed in Canada.

Consumption

Canada consumed about 123 thousand metric tons of nylon 6 and 66 in 2015. Nylon resin applications consumed about 36% of the total; the remainder is consumed in fiber applications. In the last five years, consumption of nylon in the region has declined at about 3% per year, particularly driven by a reduction in fiber produced in Canada. Nylon resin applications have been growing at a rate of about 2.7% per year.

The following table presents Canadian consumption of nylon 6 resins:

Canadian consumption of nylon 6
(thousands of metric tons)

	Automotive	Electrical and electronic	Appliances	Film and coating	Wire and cable	Consumer	Industrial/ machinery	Other	Total
2005	6	1	-	9	1	-	1	1	19
2006	6	1	-	8	1	-	1	1	18
2007	7	1	-	8	1	-	-	1	18
2008	6	-	-	8	1	-	-	1	16
2009	4	-	-	7	-	-	-	1	12
2010	5	-	-	8	1	-	-	1	15
2011	6	-	-	8	1	-	-	1	16
2012	6	-	-	8	1	-	-	1	17
2013	6	-	-	8	1	-	-	1	17
2014	6	-	-	8	1	-	-	1	17
2015	6	-	-	8	1	-	-	1	17
2020	5	-	-	9	1	-	-	1	16
				Average annual growth rate (percent)					
2015–20	-4.0%	—	—	1.0%	0.2%	—	—	2.0%	-0.6%

Source: IHS Chemical estimates.

The following table presents Canadian consumption of nylon 66 resins:

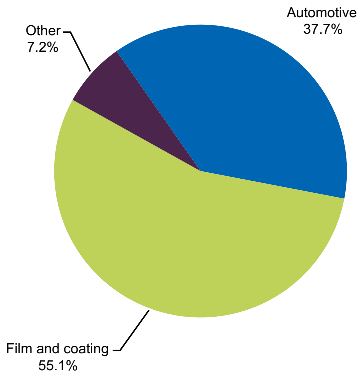
Canadian consumption of nylon 66
(thousands of metric tons)

	Automotive	Electrical and electronic	Appliances	Film and coating	Wire and cable	Consumer	Industrial/ machinery	Other	Total
2005	33	1	1	1	-	1	2	2	41
2006	31	1	1	1	-	1	2	2	39
2007	29	1	-	1	-	-	1	1	33
2008	25	1	-	1	-	-	1	1	29
2009	17	1	-	1	-	-	1	1	21
2010	20	1	-	1	-	-	1	1	24
2011	21	1	-	1	-	-	1	1	26
2012	25	1	-	1	-	-	1	1	29
2013	24	1	-	1	-	1	1	1	29
2014	24	1	-	1	-	1	1	1	29
2015	23	1	-	1	-	1	1	1	28
2020	18	1	-	1	-	1	1	1	24
				Average annual growth rate (percent)					
2015–20	-4.0%	2.1%	—	2.0%	—	2.2%	1.3%	2.0%	-2.7%

Source: IHS Chemical estimates.

The following charts show the consumption of nylon resins by end use for nylon 6 and nylon 66. The consumption of nylon 6 and nylon 66 is dominated by the automotive applications in Canada; the second-largest consuming application is film and coating, which consumes a large proportion of nylon 6.

Canadian consumption of nylon 6 by end use—2015



Source: IHS Chemical

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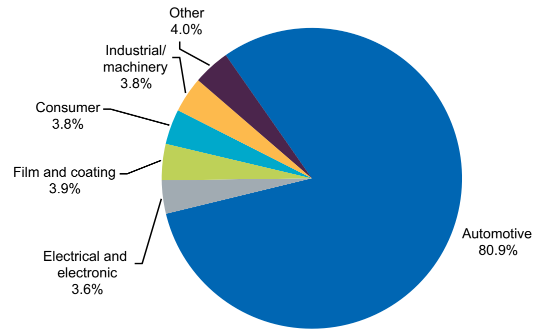
Canadian consumption of nylon 66 by end use—2015



Source: IHS Chemical

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Automotive applications have been the main driver of demand in Canada and are the largest market for nylon resins. In 2015, this market consumed more than 28 thousand metric tons of nylon resins, or 64% of the total nylon resin consumption. Nearly 80% of this market consumes nylon 66.

Nylon 66 has better properties like heat resistance, high melting point, and better chemical resistance, which makes it more resistant and the preferred resin for automotive manufacturing.

The Canadian economy is expected to grow more slowly than in the United States and Mexico over the next five years. Automobile production and the consumption of nylons for automotive applications is expected to decline by 4% over the next five years, reducing demand by more than 5 thousand metric tons by 2020.

Overall consumption of nylon resins in Canada is expected to decline by 2% per year from 2015 to 2020.

Trade

Canada imported about 29 thousand metric tons of both nylon 6 and nylon 66 in 2015, compared to exports of about 19 thousand metric tons of nylon 6 and 44 thousand metric tons of nylon 66.

The United States remains the largest nylon trading partner with Canada; the other major trading partner in 2015 was China.

Mexico

Mexico is a small producer of nylon 6 engineering resins with a nameplate capacity of 20 thousand metric tons. Mexico does not produce nylon 66; domestic demand is supplied by imports.

Producing companies

The following table lists the nylon 6 producer, plant location and average capacity in Mexico:

Mexican producers of nylon 6 (thousands of metric tons)						
		Average annual capacity				
Company	Plant location	2013	2015	2020	Raw material and and process	Remarks
Nyltek	Ocotlan	20	20	20	N 6 continuous	Former DuPont/Akra JV; 100% owned by Akra since October 2005.
Total		**20**	**20**	**20**		

Source: IHS Chemical estimates. © 2016 IHS

In 2015, the total nylon resin capacity in Mexico was 20 thousand metric tons, produced by Nyltek in Ocotlan, with applications in plastic and nylon fiber manufacture.

The Mexican market is quite small and no capacity additions are anticipated in the next five years.

Salient statistics

Nylon 6

The following table presents Mexico's supply/demand for nylon 6:

Mexican supply/demand for nylon 6 (thousands of metric tons)						
	Annual capacity	Operating rate (percent)	Production	Imports	Exports	Actual consumption
1990	45	160	72	-	-	13
1995	45	149	67	-	6	25
2000	45	49	22	-	1	17
2001	45	27	12	3	1	11
2002	45	31	14	5	7	9
2003	45	51	23	2	11	11
2004	20	100	20	8	11	14
2005	20	95	19	1	-	16
2006	20	100	20	7	1	22
2007	20	70	14	9	1	18
2008	20	60	12	6	-	14
2009	20	49	10	9	5	12
2010	20	55	11	23	7	22
2011	20	55	11	24	6	24
2012	20	77	15	29	5	34
2013	20	70	14	29	6	32
2014	20	63	13	32	7	32
2015	20	49	10	37	8	34

Source: IHS Chemical estimates. © 2016 IHS

Nylon 6 production was 10 thousand metric tons in 2015 for an operating rate of 49% of nameplate capacity.

Nylon 66

The following table presents Mexico's supply/demand for nylon 66:

Mexican supply/demand for nylon 66 (thousands of metric tons)						
	Annual capacity	Operating rate (percent)	Production	Imports	Exports	Actual consumption
1990	-	-	-	-	-	-
1995	-	-	-	16	-	-
2000	-	-	-	28	-	11
2001	-	-	-	44	-	21
2002	-	-	-	50	-	17
2003	-	-	-	49	-	20
2004	-	-	-	63	-	26
2005	-	-	-	66	4	29
2006	-	-	-	75	5	40
2007	-	-	-	62	6	33
2008	-	-	-	53	7	26
2009	-	-	-	45	-	28
2010	-	-	-	53	-	36
2011	-	-	-	53	-	39
2012	-	-	0	56	-	43
2013	-	-	-	60	-	44
2014	-	-	-	62	-	47
2015	-	-	-	64	-	49

Source: IHS Chemical estimates.

There is no nylon 66 production in Mexico. The demand for nylon 66 is addressed by imports, mainly from the United States.

Consumption

Mexico consumed about 111 thousand metric tons of nylon 6 and 66 in 2015. Nylon resin applications consumed about 75% of the total; and the remainder is consumed in fiber applications. In the last five years, consumption of nylon in the region has grown at about 4.9% per year, particularly driven by a growth in the consumption of nylon 6 resin and then nylon 66, which combine for a total growth rate of 7.5% per year. Nylon fiber applications have been declining at about 1% per year and are expected to continue to decline in the next five years.

The following table presents Mexican consumption of nylon 6 resins:

Mexican consumption of nylon 6 (thousands of metric tons)									
	Automotive	Electrical and electronic	Appliances	Film and coating	Wire and cable	Consumer	Industrial/ machinery	Other	Total
2005	13	-	1	-	1	-	-	1	16
2006	16	1	1	-	1	-	1	2	22
2007	14	-	1	-	1	-	1	1	18
2008	11	-	1	-	1	-	-	1	14
2009	9	-	1	-	1	-	-	1	12
2010	14	-	2	-	1	3	-	2	22
2011	16	-	2	-	1	3	-	2	24
2012	24	-	3	-	1	3	1	2	34
2013	22	-	3	1	1	3	-	2	32
2014	23	-	3	1	1	3	-	2	32
2015	24	0	3	1	1	3	-	2	34
2020	35	0	3	1	1	3	-	2	46
Average annual growth rate (percent)									
2015–20	7.4%	4.0%	3.8%	0.9%	2.1%	2.9%	—	2.4%	6.2%

Source: IHS Chemical estimates.

The following table presents Mexican consumption of nylon 66 resins:

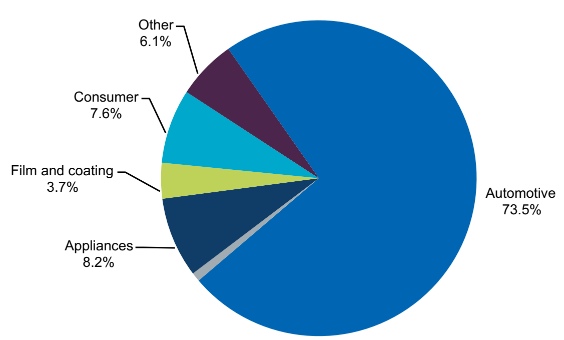
Mexican consumption of nylon 66
(thousands of metric tons)

	Automotive	Electrical and electronic	Appliances	Film and coating	Wire and cable	Consumer	Industrial/ machinery	Other	Total
2005	18	2	2	-	-	2	3	2	29
2006	23	3	3	-	-	3	4	4	40
2007	21	2	2	-	-	2	3	3	33
2008	17	2	2	-	-	1	2	2	26
2009	17	2	2	-	-	2	2	3	28
2010	23	3	2	-	-	3	2	3	36
2011	26	3	2	-	-	3	2	3	39
2012	29	3	2	-	-	3	2	3	43
2013	30	3	2	-	-	3	2	3	44
2014	33	3	2	-	-	3	2	3	47
2015	34	3	3	-	-	4	2	3	49
2020	49	4	3	-	-	4	3	4	67
			Average annual growth rate (percent)						
2015–20	7.4%	3.7%	3.8%	—	—	3.2%	3.2%	2.4%	6.2%

Source: IHS Chemical estimates. © 2016 IHS

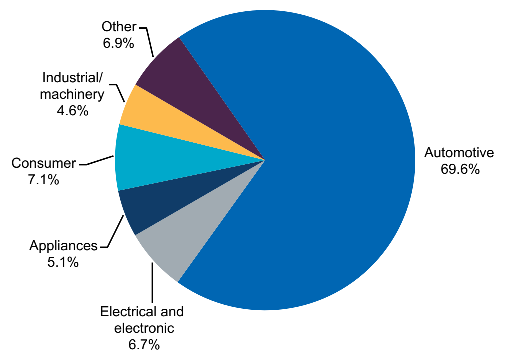
The following charts show the consumption of nylon resin by end use for nylon 6 and nylon 66. The consumption of both nylon 6 and 66 is dominated by the automotive applications in Mexico; the second-largest consuming applications are appliances and consumer applications.

Mexican consumption of nylon 6 by end use—2015



Source: IHS Chemical © 2016 IHS

Mexican consumption of nylon 66 by end use—2015



Source: IHS Chemical © 2016 IHS

Major compounders of nylon resins are described below:

- BASF installed nylon 6 and nylon 66 compounding extrusion lines at its Altamira complex in Mexico. The equipment was originally moved from Chesterfield, Virginia to Altamira in the Tamaulipas state. The nylon extrusion line is believed to supply customers along the US-Mexico border.

- Schulman Company, manufacturer of plastic resins and compounds, continues to increase capacity for engineering compounds at its plant at San Luis Potosi. Schulman, which restructured its compounding operations in Europe and North America, added 2 million metric tons of compounding capacity around 2010.

Automotive

In 2015, Mexico consumed about 58 thousand metric tons of nylon in automotive applications; nylon 66 accounts for about 59% of the total. Due to its inherent properties such as heat stability and high melting points, nylon 66 is a better choice for automotive applications than nylon 6.

The consumption of nylon resin for automotive applications is estimated to grow at about 7.4% per year for the next five years, reaching 84 thousand metric tons by 2020.

Other

The other end-use applications for nylon resins each consumed 1–4 thousand metric tons in 2015 and totaled nearly 25 thousand metric tons. In the next five years, these are expected to grow at an average rate of 3.1% per year and reach a combined total of neary 29 thousand metric tons by 2020.

Trade

A majority of Mexico's trade is with the United States; small amounts of trade are conducted with Argentina, China, and Western European countries.

The Mexican nylon market has been mainly import driven; almost all domestic consumption is addressed by imports. Mexico imported about 37 thousand metric tons of nylon 6 in 2015. Since the production of nylon 6 is not very significant in Mexico, there is virtually no export of nylon 6, although in 2015 it did account for about 8 thousand metric tons.

More than 64 thousand metric tons of nylon 66 were imported in 2015. No nylon 66 plants are expected to be constructed in Mexico, so imports will continue to rise with demand.

South America

South America produces both nylon 6 and nylon 66. The region has a much larger capacity for nylon 66 resins, at about one and a half times the capacity of nylon 6. Brazil is the region's largest producer, accounting for 120 thousand metric tons of nylon capacity. South America is a net importer of both nylon 6 and nylon 66 resins.

Producing companies

The following table presents the producers of nylon 6 resins in South America:

South American producers of nylon 6
(thousands of metric tons)

Company	Plant location	Average annual capacity 2013	2015	2020	Raw material and and process	Remarks
Argentina						
SNIAFA	Hernandez-La Plata	0	0	0	N 6 autoclave	Idled in 2010.
Brazil						
BASF	Sao Bernardo	0	5	0	N 6 continuous	
INVISTA	Americana	25	25	25	N 6 continuous	
Mazzaferro	Sao Bernardo	25	0	0	N 6 continuous	
Colombia						
Enka de Col.	Medellin	18	18	18	N 6 continuous	
Hilazas Vanylon	Barranquilla	7	7	7	N 6 continuous	
Total		**75**	**55**	**50**		

Source: IHS Chemical estimates.

The total nylon 6 polymerization capacity in South America was 55 thousand metric tons in 2015 among four producers. INVISTA is the largest producer of nylon 6 in South America with a capacity of about 25 thousand metric tons. A fifth producer, SNIAFA, idled its 5 thousand metric ton plant at the end of 2010, reducing the regional capacity from 95 thousand to 90 thousand metric tons. In the second quarter of 2014, BASF acquired the nylon 6 production plant for Mazzaferro at Sao Bernado. BASF operated the plant for about another year before shutting it down at the end of first-quarter 2015.

The following table presents the producers of nylon 66 resins in South America:

South American producers of nylon 66
(thousands of metric tons)

Company	Plant location	Average annual capacity 2013	2015	2020	Raw material and process	Remarks
Argentina						
INVISTA	Berazategui	50	25	0	N 66 autoclave	Capacity esti-mated.
Brazil						
Rhodia	Santo Andre	50	50	50	N 66 autoclave	
	Sao Bernardo	30	30	30	N 66 continuous	
Total		**130**	**105**	**80**		

Source: IHS Chemical estimates. © 2016 IHS

The total nylon polymerization capacity for nylon 66 was 105 thousand metric tons in 2015. The nylon 66 polymerization capacity is dedicated to resins production. There are two producers of nylon 66 in South America, INVISTA and Rhodia. Rhodia (owned by Solvay) has two locations for producing nylon 66 with capacities of 50 thousand and 30 thousand metric tons. INVISTA was the only company that produced both nylon 6 and nylon 66 (in different locations) in South America, but the company stopped production of nylon 66 in 2016.

Brazil is South America's largest nylon 66 producer, with nearly 76% of total regional capacity in 2015; and with 100% capacity going forward in 2016.

Salient statistics

Nylon 6

The following table presents South American supply/demand for nylon 6:

South American supply/demand for nylon 6
(thousands of metric tons)

	Annual capacity	Operating rate (percent)	Production	Imports	Exports	Actual consumption
1990	28	111	31	1	-	19
1995	47	140	66	11	3	19
2000	88	74	65	38	15	18
2001	78	76	59	31	6	24
2002	78	74	58	30	7	30
2003	88	73	64	42	11	35
2004	94	67	63	48	11	37
2005	92	62	57	39	11	40
2006	95	64	61	44	11	39
2007	95	62	59	53	13	45
2008	95	64	61	51	14	48
2009	95	52	50	43	8	44
2010	95	48	46	47	5	48
2011	90	37	33	46	2	47
2012	85	43	36	42	2	48
2013	75	55	42	45	2	51
2014	95	36	34	42	2	45
2015	55	34	19	45	1	41

Source: IHS Chemical estimates.

South America produced about 19 thousand metric tons of nylon 6 at a operating rate of about 34% in 2015. With the shutdown of BASF's plant in Brazil, the operating rate is forecast to increase to about 63% by 2020.

Nylon 66

The following table presents South American supply/demand for nylon 66:

South American supply/demand for nylon 66
(thousands of metric tons)

	Annual capacity	Operating rate (percent)	Production	Imports	Exports	Actual consumption
1990	30	360	108	1	3	16
1995	30	297	89	-	3	13
2000	105	90	95	-	7	17
2001	105	82	86	-	9	14
2002	105	79	83	-	9	14
2003	105	87	91	-	12	19
2004	125	81	101	5	19	25
2005	130	81	105	7	22	27
2006	130	84	109	7	30	30
2007	130	78	102	15	23	37
2008	130	68	88	18	18	37
2009	130	78	101	14	30	38
2010	130	81	105	31	40	48
2011	130	84	110	38	48	51
2012	130	71	92	46	40	51
2013	130	80	104	35	35	54
2014	130	76	99	27	29	49
2015	105	74	78	30	26	44

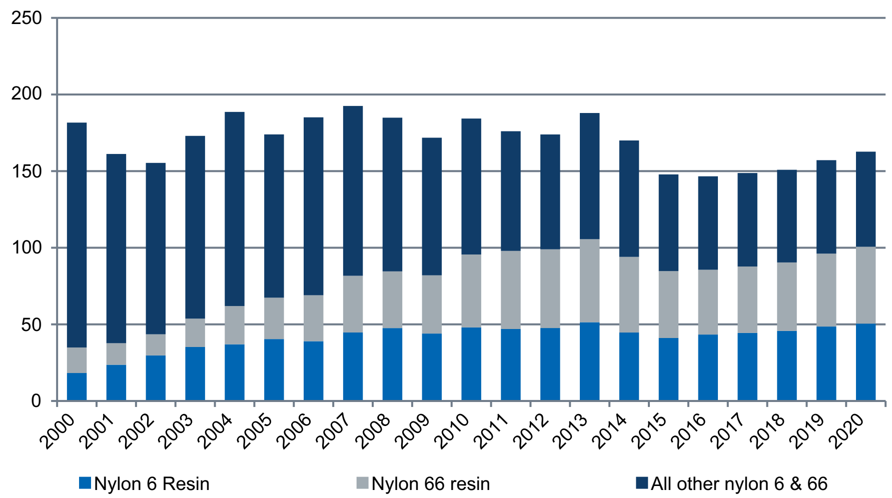
Source: IHS Chemical estimates.

There is a much larger capacity for nylon 66 in South America compared with nylon 6. The total production was about 78 thousand metric tons in 2015. Nylon 66 production in the region has declined about 5.9% per year since 2010, but dramatically dropped in 2015 from 99 thousand metric tons. Even so, the region's overall supply was maintained at around 107 thousand metric tons by an increase in imports. After trade, South America consumed about 82 thousand metric tons of nylon 66 in 2015. Nylon resin applications accounted for nearly 44 thousand metric tons or about 53% of the total.

Consumption

South America consumed about 148 thousand metric tons of nylon 6 and 66 in 2015. Nylon resin applications consumed about 57% of the total; and the remainder is consumed in fiber applications. In the last five years, total consumption of nylon in the region has declined at about 4.3% per year, particularly driven by a reduction in fiber produced in the region. Nylon 66 resin applications have been declining at a slower rate; however, overall consumption of nylon resins has declined by 2.4% per year. The markets for nylon are expected to recover in the next few years, driven by demand for nylon 6 resins.

South American consumption of nylon by application



Notes: Data are in thousands of metric tons
Source: IHS Chemical

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The following table presents South American consumption of nylon 6 resins:

South American consumption of nylon 6
(thousands of metric tons)

	Automotive	Electrical and electronic	Appliances	Film and coating	Wire and cable	Consumer	Industrial/ machinery	Other	Total
2005	19	2	2	5	-	3	3	6	40
2006	18	2	2	6	-	3	3	5	39
2007	21	2	2	8	-	3	3	6	45
2008	22	2	2	9	-	4	3	6	48
2009	22	2	2	10	-	2	2	4	44
2010	24	2	2	11	-	2	2	5	48
2011	24	2	2	11	-	2	2	4	47
2012	24	2	2	10	-	2	2	5	48
2013	26	2	2	11	-	2	2	5	51
2014	23	2	2	11	-	2	2	3	45
2015	20	2	2	10	-	2	2	3	41
2020	25	2	3	11	-	2	2	6	50
			Average annual growth rate (percent)						
2015–20	4.5%	1.2%	2.1%	3.0%	—	1.1%	1.1%	11.9%	4.2%

Source: IHS Chemical estimates.

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The following table presents South American consumption of nylon 66 resins:

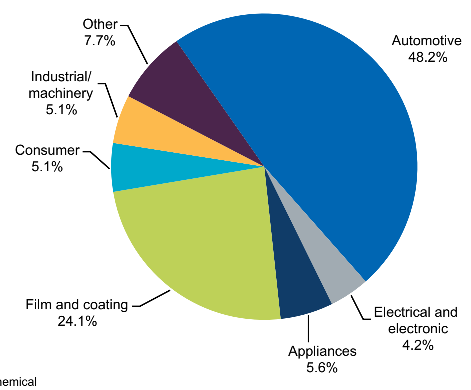
South American consumption of nylon 66
(thousands of metric tons)

	Automotive	Electrical and electronic	Appliances	Film and coating	Wire and cable	Consumer	Industrial/ machinery	Other	Total
2005	14	2	1	-	-	2	5	3	27
2006	17	2	1	-	-	2	5	3	30
2007	23	2	1	-	-	2	6	3	37
2008	24	2	1	-	-	2	5	3	37
2009	24	2	2	-	-	2	5	3	38
2010	29	3	3	-	-	2	6	4	48
2011	31	3	3	-	-	3	6	5	51
2012	31	3	4	-	-	3	6	5	51
2013	33	3	4	-	-	3	6	5	54
2014	28	3	4	-	-	3	6	5	49
2015	22	3	4	-	-	3	6	5	44
2020	28	3	4	-	-	3	7	6	50
Average annual growth rate (percent)									
2015–20	4.3%	1.2%	1.1%	—	—	1.1%	1.1%	1.4%	2.8%

Source: IHS Chemical estimates.

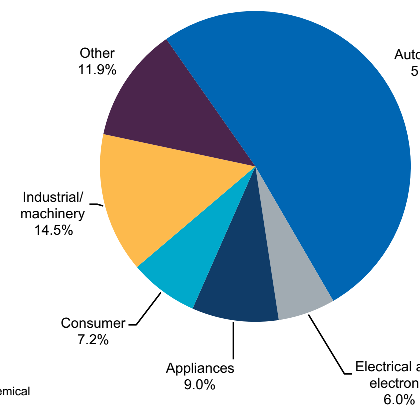
The following charts show the consumption of nylon 6 and nylon 66 resins by end use. The consumption of both is dominated by the automotive applications in South America; the second-largest consuming application is film and coating, which consumes a large proportion of nylon 6.

South American consumption of nylon 6 by end use—2015



Source: IHS Chemical

South American consumption of nylon 66 by end use—2015



Source: IHS Chemical

Automotive

In 2015, South America produced about 3.2 million vehicles or 3.5% of the world total production. Automotive applications consumed about 42 thousand metric tons of nylon resins in 2015, split between 22 thousand metric tons of nylon 66 and 20 thousand metric tons of nylon 6.

Brazil's automobile industry contributed to significant demand growth for nylon resins since 2005. Automotive under-the-hood applications continue to represent a significant opportunity for increased use of nylon 66 resins due to their high heat resistance, chemical resistance, high melting point, and tensile strength.

In the next five years, the region is expected to increase vehicle production to about 3.9 million vehicles at growth rate of about 4.2% per year. Regional nylon resin consumption for automotive uses is expected to increase at a similar 4.4% per year and reach 52 thousand metric tons by 2020.

Film and coating

Film and coating applications consumed nearly 10 thousand metric tons of nylons, all nylon 6. Average annual growth of 3% is expected through 2020.

Other applications consumed comparatively much smaller volumes of nylon resins.

Trade

In 2015, South America was a net importer of both nylon 6 and of nylon 66. Extraregional imports are mainly from the United States and Western Europe, while exports go mainly to Asia.

The import and export volumes of nylon 6 were nearly 45 thousand metric tons and less than 1 thousand metric tons, respectively in 2015. The import and export volumes of nylon 66 totaled 30 thousand metric tons and 26 thousand metric tons, respectively, in 2015. Imports of nylon 66 are expected to increase, due to reduced regional capacity and production.

The largest importing and exporting countries of nylon resins in South America have historically been Argentina and Brazil.

Western Europe

Western Europe has the second-largest capacity for nylon resins in the world, after China and the United States. The region has a much larger capacity for nylon 6 than for nylon 66, with Germany being the largest producer in the region with nearly half of the total capacity.

Producing companies

The total nylon 6 capacity in Western Europe is estimated to be 1,074 thousand metric tons in 2015. There are a total of 12 producers operating 16 plants in Western Europe, distributed in Belgium, Germany, Italy, the Netherlands, Spain, and Switzerland.

Western European producers of nylon 6
(thousands of metric tons)

Company	Plant location	Average annual capacity 2013	2015	2020	Raw material and and process	Remarks
Belgium						
BASF Antwerp	Antwerp	90	90	90	N 6 continuous	
Beaulieu-Nylon	Kruishoutem	42	42	42	N 6 continuous	Spinning and ETP resin.
LANXESS	Antwerp	0	90	90	N 6 continuous	ETP resin.
Germany						
BASF SE	Ludwigshafen	165	165	165	N 6 continuous	
	Rudolstadt	0	0	0	N 6 continuous	Compounding remains open
DOMO Chemicals	Leuna	100	100	100	N 6 continuous	
	Premnitz	9	9	9	N 6 continuous	
Grupa Azoty	Guben	45	45	45	N 6 continuous	From Unylon AG. To Grupa Azoty ATT Polymers.
Grupa Azoty ATT	Guben	24	48	48	N 6 continuous	From Grupa Azoty.
LANXESS	Uerdingen	120	120	120	N 6 continuous	From Bayer.
Italy						
Aquafil SpA Arco	Arco di Trento	55	55	55	N 6 continuous	
Radici Fibres spA	Casnigo	48	48	48	N 6 continuous	
	Villa d'Ogna	65	65	65	N 6 continuous	
Netherlands						
DSM Eng. Plastics	Emmen	120	120	120	N 6 continuous	
Spain						

Western European producers of nylon 6 (continued)
(thousands of metric tons)

Company	Plant location	Average annual capacity 2013	2015	2020	Raw material and and process	Remarks
Nurel	Zaragoza	27	27	27	N 6 continuous	For fiber and plastics.
Ube Industries	Castellon Plana	22.5	30	40	N 6 continuous	
Switzerland						
EMS-CHEMIE	Domat Ems	20	20	20	N 6 continuous	
Total		**953**	**1,074**	**1,084**		

Source: IHS Chemical estimates.

Germany has the largest capacity for nylon 6 in Western Europe with five producers and six plants and a total nameplate capacity of about 487 thousand metric tons in 2015. Belgium is the second-largest producer with a total capacity of 222 thousand metric tons in 2015. LANXESS started a new plant in Antwerp, Belgium with a capacity of 90 thousand metric tons in 2014.

Italy and the Netherlands have capacities of 168 thousand metric tons and 120 thousand metric tons, respectively, as of 2015. The capacity shares by country are Germany (45.3%), Belgium (20.7%), Italy (15.6%), and the Netherlands (11.2%), with Spain and Switzerland combined accounting for the remainder (7.2%).

Nylon 6 capacity in Western Europe is expected to increase to about 1,084 thousand metric tons by 2020 as Ube Industries in Spain is expected to increase its nameplate capacity by 10 thousand metric tons by 2018. On the other hand, DOMO Chemicals in Belgium discontinued operation at its 50 thousand metric ton Antwerp plant in 2013.

The total nylon 66 capacity in Western Europe is estimated to be 569 thousand metric tons in 2015, as shown in the following table:

Western European producers of nylon 66
(thousands of metric tons)

Company	Plant location	Average annual capacity 2013	2015	2020	Raw material and process	Remarks
France						
Meryl Fiber	Arras	0	0	0	N 66 continuous	Shut down in mid-2012.
Solvay	Saint Fons	56	56	56	N 66 continuous	From Rhodia.
Germany						
BASF SE	Ludwigshafen	110	110	110	N 66 continuous	
DuPont Germany	Uentrop	60	60	60	N 66 continuous	Capacity estimated. For plastics. Also compounding.
Polyamide HP	Obernburg	58	58	58	N 66 continuous	From Acordis.
Rhodia	Freiburg	43	43	43	N 66 continuous	
XENTRYS	Premnitz	12	12	12	N 66 continuous	
Italy						
Nylstar	Cesano-Maderno	0	0	0	N 66 autoclave	Shut down in 2008.
Radici Chim SpA	Novara	90	90	90	N 66 autoclave	
Rhodia	Ceriano Laghetto	0	0	0	N 66 autoclave	Shut down in 2009.
Netherlands						
INVISTA	Rozenburg	90	90	90	N 66 continuous	PA66 from salt.
Spain						
Solvay	Blanes	50	50	50	N 66 autoclave	From Rhodia.
Switzerland						
NEXIS Fibers	Emmenbruecke	0	0	0	N 66 autoclave	Shut down in 2009.
United Kingdom						
INVISTA	Wilton	0	0	0	N 66 continuous	Shut down in 2009.
Total		**569**	**569**	**569**		

Source: IHS Chemical estimates.

Germany has the largest capacity for nylon 66 in Western Europe with a nameplate capacity of 283 thousand metric tons in 2015. Italy and the Netherlands each have 90 thousand metric tons of nylon 66 capacity. From 2012 to 2013, France's capacity decreased from 68 thousand to 56 thousand metric tons, owing to the shutdown of Meryl Fiber's nylon 66 plant in 2012. Spain has a nameplate capacity of 50 thousand metric tons for nylon 66 resins.

In 2011, Solvay acquired Rhodia's nylon business, but continued to use the Rhodia name for the nylon 66 operations. Solvay continues to produce nylon 6. In 2016, Solvay announced a plan to sell its nylon business through Goldman Sachs.

NEXIS Fibers' 22 thousand metric ton nylon 66 plant in Switzerland and INVISTA's 50 thousand metric ton plant in the United Kingdom discontinued operation in 2009.

Changes relating to Western European producers of nylon resins were as follows:

- As a result of a gradual shift in demand for nylon toward Asia since the early 2000s and the sharp decline in demand in automotive markets brought on by the recession beginning in late 2008, a few companies began to rationalize European nylon capacity:
    - In 2009, Rhodia restructured its European nylon production by closing capacity at Ceriano-Laghetto, Italy and expanding capacity at its sites in Saint Fons, France and Gorzow, Poland.
    - In 2009, as part of a global restructuring, INVISTA decided to permanently close its nylon complex at Wilton, United Kingdom.
    - In 2010, BASF closed its shuttered nylon 6 plant at Rudolstadt, Germany (34 thousand metric tons) to reduce costs and improve competitiveness of nylon 6 in European markets.
- In 2010–12, Rhodia in Germany increased its nylon 66 capacity by 13 thousand metric tons.
- During 2011–13, DOMO shifted all production of nylon 6 to Germany, by expanding the plant in Leuna from 50 thousand to 100 thousand metric tons, while shutting down the 50 thousand metric ton plant in Gent.

Salient statistics

Nylon 6

The following table presents Western European supply/demand for nylon 6:

Western European supply/demand for nylon 6 (thousands of metric tons)						
	Annual capacity	Operating rate (percent)	Production	Imports	Exports	Actual consumption
1990	71	552	392	41	16	147
1995	212	279	591	40	11	194
2000	762	105	797	30	100	347
2001	768	100	771	40	120	354
2002	775	100	777	40	140	379
2003	775	101	781	44	164	384
2004	891	93	831	50	202	405
2005	871	94	817	55	204	421
2006	1,042	78	816	61	220	432
2007	1,001	86	862	68	260	451
2008	1,001	79	787	85	256	428
2009	983	69	679	59	260	340
2010	968	83	804	102	384	386
2011	929	87	808	107	374	395
2012	939	81	760	127	360	384
2013	953	77	735	117	330	385
2014	1,057	71	755	115	342	392
2015	1,074	75	801	101	358	403

Source: IHS Chemical estimates.

In 2015, Western Europe produced 801 thousand metric tons of nylon 6 at an operating rate of 75%. Consumption is expected to increase moderately; however, because of declining exports in the forecast period, production is forecast to decrease. With the new capacity being added, imports are also expected to decline in the next five years.

Nylon 66

The following table presents Western European supply/demand for nylon 66:

Western European supply/demand for nylon 66 (thousands of metric tons)						
	Annual capacity	Operating rate (percent)	Production	Imports	Exports	Actual consumption
1990	200	160	321	41	152	227
1995	290	258	749	10	131	349
2000	751	89	668	83	168	347
2001	751	82	619	57	130	340
2002	856	86	735	55	229	350
2003	817	89	730	60	233	339
2004	817	93	756	78	288	345
2005	847	94	798	57	304	359
2006	895	91	815	85	330	368
2007	910	90	820	90	335	369
2008	889	84	749	84	325	330
2009	672	88	595	66	253	264
2010	580	99	574	109	208	302
2011	590	98	578	114	203	316
2012	581	97	564	115	231	305
2013	569	95	539	115	219	304
2014	569	92	522	161	243	309
2015	569	94	536	167	252	319

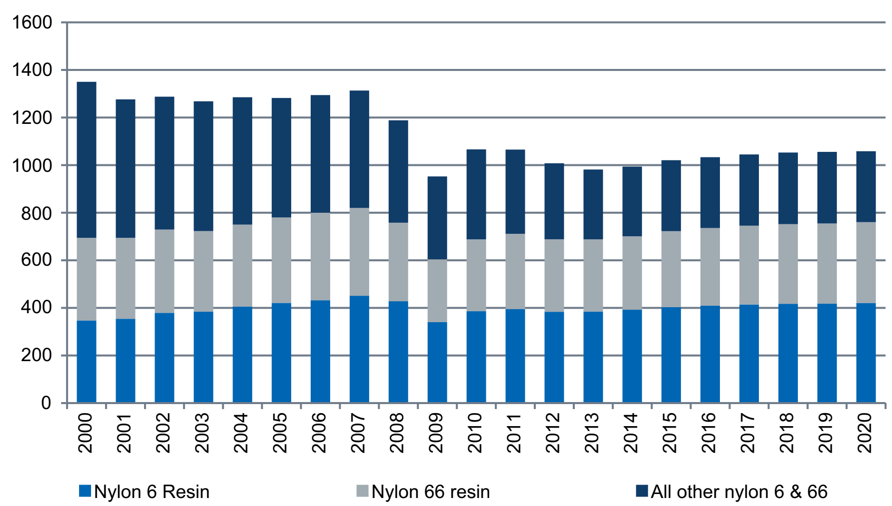
Source: IHS Chemical estimates.

In 2015, Western Europe produced 536 thousand metric tons of nylon 66 at an operating rate of 94%. In the next five years, demand is forecast to increase, which will keep the operating rates high and require additional imports in Western Europe.

Consumption

Western Europe consumed about 1 million metric tons of nylon 6 and 66 in 2015. Nylon resin applications consumed about 71% of the total and the remainder is consumed in fiber applications. In the last five years, consumption of nylon resin has been fairly stable, growing at about 1% per year; however, in the next five years overall growth of nylon consumption is expected to growth at less than 1% per year because of reduced demand for nylon in fiber applications.

Western European consumption of nylon by application



Notes: Data are in thousands of metric tons
Source: IHS Chemical

The following table presents Western European consumption of nylon 6 resins:

Western European consumption of nylon 6
(thousands of metric tons)

	Automotive	Electrical and electronic	Appliances	Film and coating	Wire and cable	Consumer	Industrial/ machinery	Other	Total
2005	156	27	13	120	-	37	50	18	421
2006	164	26	12	124	-	40	49	17	432
2007	178	27	13	128	-	44	42	19	451
2008	156	26	12	130	-	40	44	20	428
2009	111	18	9	125	-	28	35	14	340
2010	125	25	12	132	-	33	42	17	386
2011	129	26	12	132	-	35	43	18	395
2012	119	26	12	132	-	34	43	18	384
2013	119	26	11	133	-	34	43	18	385
2014	126	25	11	133	-	35	44	18	392
2015	133	26	11	134	-	35	45	19	403
2020	135	29	12	137	-	38	48	20	421
Average annual growth rate (percent)									
2015–20	0.3%	2.3%	1.6%	0.5%	—	1.7%	1.5%	1.5%	0.9%

Source: IHS Chemical estimates.

The following table presents Western European consumption of nylon 66 resins:

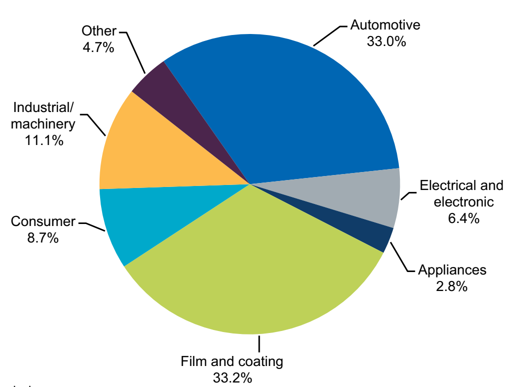
Western European consumption of nylon 66
(thousands of metric tons)

	Automotive	Electrical and electronic	Appliances	Film and coating	Wire and cable	Consumer	Industrial/ machinery	Other	Total
2005	123	84	42	17	-	36	43	14	359
2006	136	81	42	15	-	37	42	15	368
2007	140	80	40	15	-	37	42	15	369
2008	125	75	35	14	-	33	35	13	330
2009	102	62	27	12	-	25	26	10	264
2010	114	70	32	14	-	27	32	13	302
2011	117	76	34	14	-	28	34	13	316
2012	108	74	33	14	-	28	34	13	305
2013	108	74	32	14	-	28	34	13	304
2014	114	73	31	14	-	28	35	13	309
2015	121	75	31	15	-	29	35	14	319
2020	123	84	34	15	-	31	38	15	340
			Average annual growth rate (percent)						
2015–20	0.3%	2.3%	1.6%	0.5%	—	1.7%	1.5%	1.5%	1.2%

Source: IHS Chemical estimates. © 2016 IHS

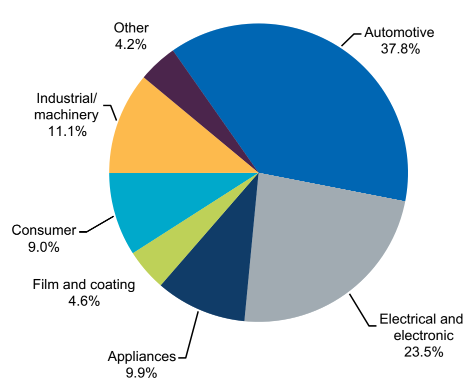
The following charts show the consumption of nylon resins by end use for nylon 6 and nylon 66. The consumption of nylon resins is dominated by the automotive applications in Western Europe; the second-largest consuming application is film and coating, which consumes a large proportion of nylon 6.

Western European consumption of nylon 6 by end use—2015



Source: IHS Chemical © 2016 IHS

Western European consumption of nylon 66 by end use—2015



Source: IHS Chemical © 2016 IHS

In 2015, the total consumption of nylon resins was about 722 thousand metric tons in Western Europe. In the next five years, the overall consumption of nylon resins is expected to grow at an average annual rate of 1.0% to reach 760 thousand metric tons by 2020.

Automotive

In 2015, Western Europe produced about 14.5 million vehicles or about 16% of the total vehicle production in the world. The total nylon consumed in this application is about 254 thousand metric tons. Automotive uses accounted for 35% of the total consumption of nylon resins in 2015. Nylon 6 accounted for 52% of the total.

In the next five years, Western Europe's vehicle production is forecast to grow at only about 0.4% per year, as production is shifted east. In the next five years, demand for nylon resin in these applications is expected to grow at around 0.3% per year and reach 258 thousand metric tons by 2020.

Automotive uses have traditionally been the largest market segment for nylon resins in Western Europe. Recent years have seen increasing demand for every type of nylon in the automotive market—particularly in under-the-hood applications, which rely on the resins' temperature and chemical resistance. New applications for high-temperature resins are considered to offer the most promise. Trends that will continue to influence demand for nylon in automotive applications include weight reduction, higher under-the-hood temperatures, need for improved noise insulation, increased design freedom, greater fuel economy, parts consolidation to reduce assembly and finishing costs, and corrosion resistance.

In order to save weight and reduce carbon emissions, automotive manufacturers are seeking to replace metal. Switching to nylon is one of their most promising options. Major application areas for nylon resins include oil pans and air intake manifolds, which offer weight savings and other technical advantages.

For certain applications, designers are taking advantage of the remarkable rigidity and tensile strength (better than many metals) of Solvay's Ixef® polyarylamide resins, which has promoted their use in automotive door handles and numerous special applications such as headlamp-control pivots.

Other examples include glass- and mineral-reinforced nylon resins for engine head covers. Mineral-reinforced nylon has replaced magnesium for cylinder head covers on BMW's more recent 2.0–2.8 liter six-cylinder engines. Properties of these nylon compounds include high strength and dimensional stability at temperatures ranging from −40°C to +140°C, achieved by a combination of nylon 66 polymer with mineral and glass fiber reinforcement.

Gas injection technology (GIT) and water injection technology (WIT) for the production, in particular, of hollow parts, finds increasing application in all fields, including for molding automotive components such as pedals and roof racks. These similar processing technologies use gas or water to displace the molten resin in the mold and form the hollow cavity. The high thermal conductivity and thermal mass of water enable cycle times to be shortened by up to 70%, in comparison with the gas-assist injection technique. The major producers of nylon resins now market specific grades for GIT and WIT applications.

Film and coating

The second-largest application of nylon resins in Western Europe is film and coatings, which consumed more than 149 thousand metric tons of nylon resins or 21% of the total consumption in 2015. In the next five years, the consumption of nylon resins in film and coating applications is expected to show sluggish growth, averaging less than 0.5% per year.

These applications consume primarily nylon 6 resins, which accounted for about 134 thousand metric tons, or 90% of the total in 2015.

Increasing demand for nylon films in Western Europe is the result of their excellent barrier and puncture resistance properties, increased use in food packaging applications, and favorable social trends. Nylon resins may be used in multilayer and laminated films. Roughly 90% of nylon film is consumed in food packaging applications.

Electrical and electronic

Electrical and electronic applications consumed about 101 thousand metric tons of nylon resins in 2015. In the next five years, consumption of nylon resins in these applications is expected to grow at an average annual rate of 2.3%.

This market accounted for 14% of the total consumption of nylon resins in 2015, led by nylon 66. The consumption by nylon type was about 26 thousand metric tons (26%) nylon 6 and 75 thousand metric tons (74%) nylon 66.

A multitude of electrical and electronics applications include relay boxes for demanding environments, which depend on outstanding toughness and rigidity at low production cost. Other components include battery boxes, coil forms, switch plates and housings, and terminal blocks.

Appliances

Appliances consumed nearly 43 thousand metric tons of nylon resins, split between nylon 6 (27%) and nylon 66 (73%) in 2015. By 2020, consumption is expected to reach nearly 47 thousand metric tons, equal to an average growth rate of about 1.6% per year in 2015–20.

Nylon extrusions and moldings are finding an increasing number of applications as components of power tools, machines, sporting goods, fastening devices, lawnmowers, snowmobiles, refrigerators, ranges, and dishwashers, among others.

Other

The remaining end-use applications of nylon resins are expected to grow at 1–2% per year through the forecast period.

- Industrial and machinery applications represented about 11% of consumption in 2015, consuming about 80 thousand metric tons of nylon resins. About 45 thousand metric tons of nylon 6 and 35 thousand metric tons of nylon 66 were consumed in these applications in 2015.

- Consumer goods had a demand of 64 thousand metric tons of nylon resins, or about 9% of the total consumption in 2015, comprised of about 35 thousand metric tons of nylon 6 and 29 thousand metric tons of nylon 66.

- Other applications consumed about 32 thousand metric tons of nylon resins in 2015, comprised of 19 thousand metric tons of nylon 6 and about 14 thousand metric tons of nylon 66.

Trade

Western European producers actively participate in nylon resins trade and the region is a net exporter of nylon resins. In 2015, Western Europe was the largest exporter of nylon 6 and the second-largest exporter of nylon 66 resins (after the United States) in the world. Western Europe imported about 101 thousand metric tons and exported 358 thousand metric tons of nylon 6 in 2015. Similarly for nylon 66, imports were 167 thousand metric tons and exports were 252 thousand metric tons in 2015. The main destination for Western Europe's nylon resin is Central Europe, which accounted for about 43% of the total. Northeast Asia is the second-largest market for regional nylon. In the next five years, trade in nylon resins in Western Europe is expected to decline.

Central Europe

Beginning in the early 2000s with the entrance of many Central European countries into the European Union, the region's nylon industry began to slowly integrate with Western European producers, through acquisitions by international manufacturers and investors such as the Radici Group (in Romania), Gruppo Bonazzi (in Slovenia), and Rhodia (in Poland and now owned by Solvay). Central Europe produces only nylon 6; all domestic demand for nylon 66 is addressed by imports.

Producing companies

The following table presents the producers of nylon 6 resins in Central Europe:

Central European producers of nylon 6
(thousands of metric tons)

Company	Plant location	Average annual capacity 2013	2015	2020	Raw material and and process	Remarks
Poland						
Grupa Azoty	Tarnow	25	25	23	N 6 continuous	From Z.A. Tarnow.
	Tarnow	22	22	22	N 6 continuous	From Z.A. Tarnow.
	Tarnow	0	0	80	N 6 continuous	Film applications and engineering plastics.

Central European producers of nylon 6 (continued)
(thousands of metric tons)

Company	Plant location	Average annual capacity 2013	2015	2020	Raw material and and process	Remarks
Rhodia Polyamide	Gorzow	30	30	30	N 6 continuous	Also EP compounding.
Slovenia						
Julon	Ljubljana	35	35	35	N 6 autoclave	For plastics and film.
Total		**112**	**112**	**190**		

Source: IHS Chemical estimates. © 2016 IHS

The total nylon resin capacity was 112 thousand metric tons in Central Europe in 2015. Currently there are three producers of nylon 6 in Central Europe, one in Slovenia and two in Poland.

The region has seen a reduction in capacity from 200 thousand metric tons in 2007 to 112 thousand metric tons (since 2010). Four plants have been shut down in Central Europe, two in Slovakia and one each in the Czech Republic and Romania, removing nearly 70 thousand metric tons of capacity:

- Nylstar in Slovakia closed their 25 thousand metric ton plant in 2010.
- Nexis Fibers in Slovakia closed their 32 thousand metric ton plant in 2009.
- Spolana in the Czech Republic closed their 3 thousand metric ton plant in 2008.
- Yarnea in Romania closed their 9 thousand metric ton nylon 6 plant in 2006.

Grupa Azoty started construction of a new 80 thousand metric ton nylon 6 unit at Tarnow in September 2015. It is anticipated that production will start in 2017. Central Europe's total capacity then will reach about 190 thousand metric tons.

There is no capacity for nylon 66 in Central Europe.

Salient statistics

Nylon 6

The following table presents Central European supply/demand for nylon 6:

Central European supply/demand for nylon 6
(thousands of metric tons)

	Annual capacity	Operating rate (percent)	Production	Imports	Exports	Actual consumption
1990	32	0	-	2	-	-
1995	122	72	87	13	18	9
2000	164	86	141	6	27	18
2001	164	78	127	12	22	26
2002	144	90	129	39	46	16
2003	159	68	108	62	51	23
2004	128	97	124	66	70	26
2005	168	57	96	72	64	30
2006	164	61	100	86	73	39
2007	200	36	72	108	56	56
2008	167	50	83	107	70	53
2009	120	56	67	108	74	46
2010	112	56	62	147	94	64

Central European supply/demand for nylon 6 (continued)
(thousands of metric tons)

	Annual capacity	Operating rate (percent)	Production	Imports	Exports	Actual consumption
2011	112	54	60	161	98	68
2012	112	65	72	160	118	68
2013	112	68	76	171	125	74
2014	112	74	83	194	145	83
2015	112	77	86	213	154	91

Source: IHS Chemical estimates.

In 2015, Central Europe produced 86 thousand metric tons of nylon 6 resins at an operating rate of 77%. The new plant in Poland (2017) will increase regional capacity and capacity utilization rates are expected to fall to about 60–61% over the next five years.

Nylon 66

The following table presents Central European supply/demand for nylon 66:

Central European supply/demand for nylon 66
(thousands of metric tons)

	Annual capacity	Operating rate (percent)	Production	Imports	Exports	Actual consumption
1990	-	-	-	-	-	-
1995	-	-	-	0	-	-
2000	-	-	-	2	-	-
2001	-	-	-	2	-	-
2002	-	-	-	22	5	2
2003	-	-	-	12	6	4
2004	-	-	-	13	3	8
2005	-	-	-	16	5	6
2006	-	-	-	31	7	10
2007	-	-	-	33	4	16
2008	-	-	-	29	4	14
2009	-	-	-	35	-	17
2010	-	-	-	46	-	25
2011	-	-	-	53	-	26
2012	-	-	-	54	-	30
2013	-	-	-	55	-	31
2014	-	-	-	63	-	33
2015	-	-	-	65	0	36

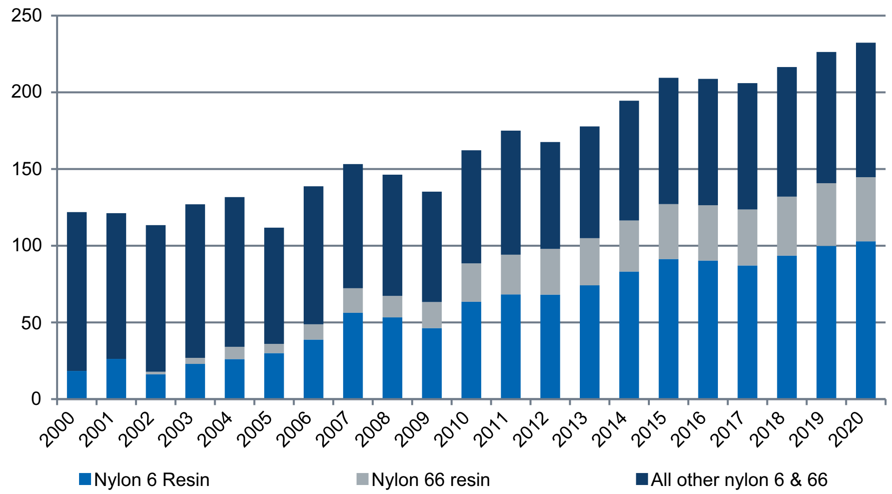
Source: IHS Chemical estimates.

There is no capacity for nylon 66 in Central Europe and all of the domestic demand is supplied by imports, mainly from Western Europe. In 2015, about 36 thousand metric tons of nylon 66 resins were consumed in Central Europe, or about 55% of the total consumption.

Consumption

Central Europe consumed about 209 thousand metric tons of nylon 6 and 66 in 2015. Nylon resin applications consumed about 39% of the total and the remainder is consumed in fiber applications. In the last five years, total consumption of nylon in the region has grown at about 5.2% per year; however, in the next five years consumption is expected to be reduced because of declining demand for nylon in fiber applications.

Central European consumption of nylon by application



Notes: Data are in thousands of metric tons
Source: IHS Chemical
© 2016 IHS

The following table presents Central European consumption of nylon 6 resins:

Central European consumption of nylon 6
(thousands of metric tons)

	Automotive	Electrical and electronic	Appliances	Film and coating	Wire and cable	Consumer	Industrial/ machinery	Other	Total
2005	14	1	1	3	-	-	6	5	30
2006	20	2	1	3	-	1	6	6	39
2007	35	3	1	4	-	-	7	6	56
2008	31	3	1	5	-	-	7	6	53
2009	28	2	1	4	-	-	5	6	46
2010	37	4	2	4	-	2	7	8	64
2011	39	5	3	4	-	2	7	8	68
2012	40	5	3	4	-	2	7	7	68
2013	45	5	3	4	-	2	7	7	74
2014	54	5	3	4	-	2	8	7	83
2015	60	5	3	4	-	2	8	8	91
2020	67	7	4	4	-	2	9	9	103
				Average annual growth rate (percent)					
2015–20	2.2%	5.7%	4.2%	0.6%	—	0.8%	2.5%	2.3%	2.4%

Source: IHS Chemical estimates.
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The following table presents Central European consumption of nylon 66 resins:

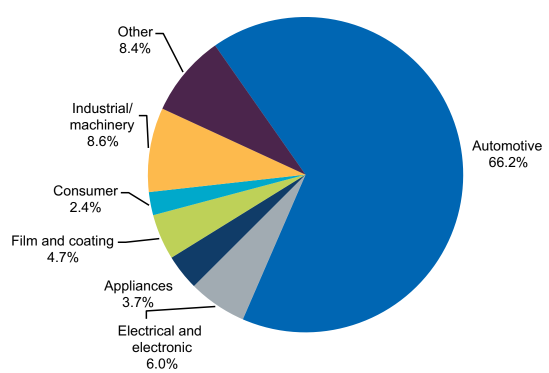
Central European consumption of nylon 66
(thousands of metric tons)

	Automotive	Electrical and electronic	Appliances	Film and coating	Wire and cable	Consumer	Industrial/ machinery	Other	Total
2005	4	1	-	-	-	-	-	1	6
2006	8	1	-	-	-	-	-	1	10
2007	13	2	-	-	-	-	-	1	16
2008	11	2	-	-	-	-	-	1	14
2009	13	3	-	-	-	-	-	1	17
2010	17	3	1	-	-	1	2	1	25
2011	18	3	1	-	-	1	2	1	26
2012	20	4	2	-	-	1	3	2	30
2013	21	3	2	-	-	1	3	2	31
2014	23	4	2	-	-	1	3	2	33
2015	25	4	2	-	-	1	3	2	36
2020	28	5	2	-	-	1	3	2	42
			Average annual growth rate (percent)						
2015–20	2.7%	5.9%	5.1%	—	—	1.8%	2.8%	2.1%	3.2%

Source: IHS Chemical estimates.

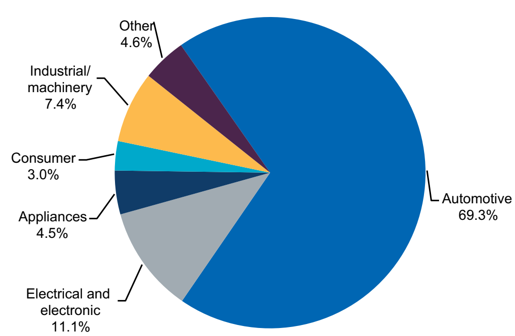
The following charts show the consumption of nylon resin by end use for nylon 6 and nylon 66. The consumption of nylon resins is dominated by the automotive applications in Central Europe; the second-largest consuming application is film and coatings, which consumes a large proportion of nylon 6.

Central European consumption of nylon 6 by end use—2015



Source: IHS Chemical

Central European consumption of nylon 66 by end use—2015



Source: IHS Chemical

Automotive

In 2015, the region produced about 3.9 million vehicles or about 4.3% of the total vehicle production in the world. The total nylon consumed in this application is about 85 thousand metric tons with nylon 6 accounting for 71% of the total. In the next five years, Central European vehicle production is forecast to grow at about 4.3% per year. Demand for nylon resin in automotive applications is expected to grow at around 2.3% per year, to reach 96 thousand metric tons by 2020.

Industrial and machinery

Industrial and machinery applications consumed nearly 11 thousand metric tons of nylon resins in 2015, accounting for about 8% of the total market. Nylon 6 accounts for the majority of consumption (73%); these uses are expected to grow at about 2.5% per year and reach 12 thousand metric tons by 2020.

Electrical and electronic

Electrical and electronic applications consumed about 10 thousand metric tons of nylon resins in 2015, representing nearly 8% of the total market. Nylon 6 accounts for about 58% of the total. These applications are expected to grow at 5.6% per year through the forecast period.

Other applications of nylons are much smaller in volume as shown in the table.

Trade

Central Europe is a net importer of both types of nylon resins, although the region has its own production. In 2015, the region imported around 213 thousand metric tons and exported 154 thousand metric tons of nylon 6. Imports and exports between Western Europe and Central Europe account for most of the trade in Central Europe.

There is no domestic production of nylon 66; the region imported the entire consumption requirements of about 64 thousand metric tons in 2015. The majority of these imports came from Western Europe. Central Europe will continue to be a net importer.

CIS and Baltic States

The CIS and Baltic States produced both nylon 6 and nylon 66 until the small nylon 66 plant, capacity of only 14 thousand metric tons, was shut down in 2013. Nylon 6 is produced on a much larger scale and the region is a significant exporter. The domestic demand for nylon 66 is only a few thousand metric tons. A great portion of regional nylon production is converted into fibers.

Producing companies

The following table presents the nylon 6 producers in the CIS and Baltic States:

CIS and Baltic States producers of nylon 6
(thousands of metric tons)

Company	Plant location	Average annual capacity 2013	2015	2020	Raw material and and process	Remarks
Belarus						
JSC Grodno Khim.	Grodno	47	47	47	N 6 continuous	
	Grodno	47	47	47	N 6 continuous	
	Grodno	0	18	35	N 6 continuous	
Russia						
JSC Intekhplast	Vladimir	3	3	3	N 6 continuous	For plastics, from recycled resins.
KuibyshevAzot	Togliatti	54	54	112	N 6 continuous	Fibers.
	Togliatti	96	96	96	N 6 continuous	Uhde technology. Fibers and plastics.
JSC Kursk Khim.	Kursk	41	41	41	N 6 continuous	Capron 100%.
JSC Metafrax	Gubakha	2	2	2	N 6 continuous	
Shchekino JSC Khim.	Shchekino	34	34	34	N 6 continuous	
JSC Sibur Volzhsky	Volzhskiy	28	28	28	N 6 continuous	
Total		**352**	**370**	**445**		

Source: IHS Chemical estimates. © 2016 IHS

The total nylon 6 resin capacity in the CIS and Baltic States was about 370 thousand metric tons in 2015. There are seven producers of nylon 6 in the region.

- Kuibyshev Azot in Russia is the largest producer with a capacity of 150 thousand metric tons. Recent expansions in the last five years, have allowed the company to manufacture products in various viscosity ranges for captive fiber and tire cord production, as well as for sale for compounding into engineering resins.

- JSC Grodno Khim in Belarus is the second-largest producer with a capacity of 112 thousand metric tons in 2015. Grondo Khim expanded its total capacity by 35 thousand metric tons in midyear.

JSC Chernigov Khimica was the only producer of nylon 66 in the CIS and Baltic States and the only company to produce both types of nylon resins. The company ceased operations at Chernigov in 2013, shutting down the 23 thousand metric ton nylon 6 plant and the 14 thousand metric ton nylon 66 plant.

Salient statistics

Nylon 6

The following table presents CIS and Baltic State supply/demand for nylon 6:

CIS and Baltic States supply/demand for nylon 6
(thousands of metric tons)

	Annual capacity	Operating rate (percent)	Production	Imports	Exports	Actual consumption
1990	172	0	-	-	-	-
1995	-	-	100	3	3	2
2000	368	25	93	4	6	5
2001	365	24	88	5	5	4
2002	314	36	114	4	6	4
2003	346	47	163	14	15	28
2004	340	53	179	18	39	36
2005	337	52	175	20	45	28
2006	289	59	171	19	46	27
2007	312	68	211	19	76	39
2008	278	69	191	21	83	32
2009	278	58	160	12	82	20
2010	278	72	199	17	87	41
2011	310	73	227	18	105	52
2012	375	59	222	26	102	54
2013	352	67	236	20	111	54
2014	352	71	250	26	140	48
2015	370	69	255	23	154	36

Source: IHS Chemical estimates.

In 2015, the CIS and Baltic States produced 255 thousand metric tons of nylon 6 resins at an operating rate of 69%. The region is not a large importer of nylon 6, so total supply was about 278 thousand metric tons. Exports accounted for 55% of the total supply, with total consumption of 124 thousand metric tons in 2015. Nylon resins accounted for 36 thousand metric tons, or about 29% of the nylon 6 consumed in 2015.

In the next five years, the total demand for nylon 6 is expected to increase at a moderate rate (2–3% per year), but nylon resin applications will grow at a much faster rate (10% per year) over the next five years.

Nylon 66

The following table presents CIS and Baltic State supply/demand for nylon 66:

CIS and Baltic States supply/demand for nylon 66
(thousands of metric tons)

	Annual capacity	Operating rate (percent)	Production	Imports	Exports	Actual consumption
1990	-	-	-	-	-	-
1995	-	-	-	-	-	-
2000	-	-	-	-	-	-

CIS and Baltic States supply/demand for nylon 66 (continued)
(thousands of metric tons)

	Annual capacity	Operating rate (percent)	Production	Imports	Exports	Actual consumption
2001	-	-	-	-	-	-
2002	-	-	-	8	-	-
2003	14	24	3	2	-	-
2004	14	16	2	-	-	-
2005	14	46	7	-	-	-
2006	14	64	9	-	-	-
2007	14	51	7	1	-	-
2008	14	49	7	2	-	2
2009	14	0	-	2	-	2
2010	14	0	-	2	-	2
2011	14	0	-	4	-	4
2012	14	0	-	3	-	3
2013	-	-	-	3	-	3
2014	-	-	-	2	-	2
2015	-	-	-	2	-	2

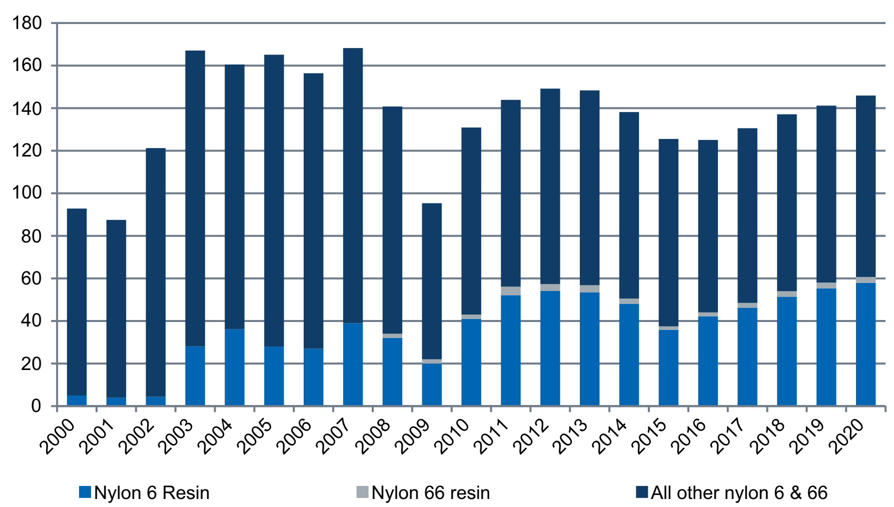
Source: IHS Chemical estimates.

The Chernigov Khimica (14 thousand metric tons) nylon 66 plant was shut down in 2013, but production had been intermittent. There is believed to have been no production in the years before the shutdown. Demand in the region is very small, and consumption is satisfied by imports.

Consumption

The CIS and Baltic States consumed about 126 thousand metric tons of nylon 6 and 66 in 2015. Nylon resin applications consumed about 29% of the total; the remainder was consumed in fiber applications. Nylon 6 resin accounted for the majority of the 37 thousand metric tons consumed. In the last five years, consumption of nylon in the region has declined at about 0.8% per year, slowed by nylon fiber production. Nylon 6 resin applications have declined in the last five years, but are expected to recover by 2020; consumption of nylon 66 remains at a few thousand metric tons per year.

CIS consumption of nylon by application



Notes: Data are in thousands of metric tons
Source: IHS Chemical

The following table presents CIS and Baltic State consumption of nylon 6 resins:

CIS and Baltic States consumption of nylon 6
(thousands of metric tons)

	Automotive	Electrical and electronic	Appliances	Film and coating	Wire and cable	Consumer	Industrial/ machinery	Other	Total
2005	16	1	2	2	-	1	4	2	28
2006	15	1	2	2	-	1	4	2	27
2007	25	1	2	2	-	1	6	2	39
2008	20	1	1	1	-	1	6	2	32
2009	12	1	1	1	-	1	3	2	20
2010	24	2	2	3	-	2	5	3	41
2011	29	4	3	3	-	3	6	4	52
2012	30	4	3	3	-	3	6	5	54
2013	29	4	3	3	-	3	6	5	54
2014	24	4	3	3	-	3	6	5	48
2015	18	4	3	3	-	3	6	(0)	36
2020	33	4	3	3	-	3	6	5	58
				Average annual growth rate (percent)					
2015–20	13.2%	2.8%	1.7%	0.5%	—	1.1%	1.4%	—	10.1%

Source: IHS Chemical estimates.

The following table presents CIS and Baltic State consumption of nylon 66 resins:

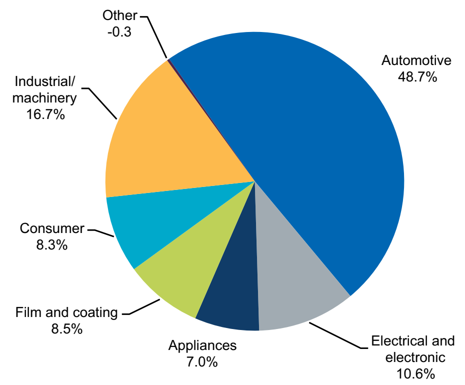
CIS and Baltic States consumption of nylon 66
(thousands of metric tons)

	Automotive	Electrical and electronic	Appliances	Film and coating	Wire and cable	Consumer	Industrial/ machinery	Other	Total
2005	-	-	-	-	-	-	-	-	-
2006	-	-	-	-	-	-	-	-	-
2007	-	-	-	-	-	-	-	-	-
2008	2	-	-	-	-	-	-	-	2
2009	2	-	-	-	-	-	-	-	2
2010	2	-	-	-	-	-	-	-	2
2011	3	-	-	-	-	-	-	1	4
2012	2	-	-	-	-	-	-	1	3
2013	2	-	-	-	-	-	-	1	3
2014	1	-	-	-	-	-	-	1	2
2015	1	-	-	-	-	-	-	1	2
2020	2	-	-	-	-	-	-	1	3
				Average annual growth rate (percent)					
2015–20	22.4%	—	—	—	—	—	—	2.9%	11.3%

Source: IHS Chemical estimates.

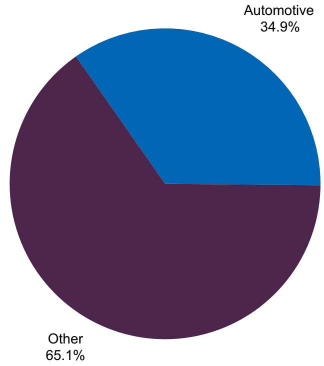
The following charts show the consumption of nylon resins by end use for nylon 6 and nylon 66. Consumption of nylon resins is dominated by the automotive applications in the CIS and Baltic States.

CIS consumption of nylon 6 by end use—2015



Source: IHS Chemical © 2016 IHS

CIS and Baltic State consumption of nylon 66 by end use—2015



Source: IHS Chemical © 2016 IHS

Automotive applications accounted for about 42% of total nylon resin consumption in 2015. The CIS and Baltic States produced about 1.5 million vehicles in 2015, down from the previous year's production of 2.2 million. This decline was reflected in the regional consumption of nylon resin, which fell nearly 40% from 25 thousand to 18 thousand metric tons in the same time period.

Automotive uses consumed nearly 18 thousand metric tons of nylon 6, or about half of total nylon 6 consumption in 2015. In the next five years, total consumption of nylon resins in this application is expected to grow at a healthy rate of about 13.4% and reach 34 thousand metric tons by 2020, due to recovery of the automotive market and specifically growth in the use of nylon in under-the-hood automotive applications.

Other applications of nylons were fairly small, ranging from 3 thousand to 6 thousand metric tons per year.

Trade

In 2015, CIS and Baltic States exported about 154 thousand metric tons of nylon 6. Northeast Asia (47%), Western Europe (23%), the Indian Subcontinent (14%), and the Middle East (10%) were the major destinations.

The region relies on imports of nylon 66 to meet demand, importing about 2 thousand metric tons in 2015.

Middle East

The Middle East has capacity to produce both nylon 6 and nylon 66. Much more nylon 66 is produced than nylon 6 but there is a larger local market for nylon 6 than for nylon 66. Additional imports satisfy the domestic demand in the region.

Producing companies

The following table presents the producers of nylon 6 in the Middle East:

Middle Eastern producers of nylon 6 (thousands of metric tons)						
		Average annual capacity				
Company	Plant location	2013	2015	2020	Raw material and and process	Remarks
Iran						
Parsylon Corp.	Khorrambad	16	16	16	N 6 continuous	
Saudi Arabia						
Petro-Rabigh	Rabigh	0	0	60	N 6 continuous	
Turkey						
Anadolu Iplik	Cerkezkoy	0	23	46	N 6 continuous	
Sifas	Bursa	0	0	0	N 6 continuous	
Total		**16**	**39**	**122**		

Source: IHS Chemical estimates.

For much of the past five years, there has been only one producer of nylon 6 operating in the Middle East, Parsylon Corp in Iran.

- In mid-2014, Turkish producer Anadolu Iplik started up a 23 thousand metric ton unit at Cerkezoy.
- In 2009, Sifas in Turkey idled its 16 thousand metric ton nylon 6 plant in Bursa.
- In mid-2016, Saudi Arabia is expected to start up its first nylon 6 plant at Rabigh, owned by Petro-Rabigh. The plant will consume caprolactam supplied from a plant at the same location.

The following table presents the producers of nylon 66 in the Middle East:

Middle Eastern producers of nylon 66 (thousands of metric tons)						
		Average annual capacity				
Company	Plant location	2013	2015	2020	Raw material and process	Remarks
Iran						
Saba Tire Cord	Zanjan	15	15	15	N 66 continuous	
Israel						
Nilit	Migdal Ha-Emek	50	50	50	N 66 continuous	
Saudi Arabia						
Saudi Polymers	Al Jubail	0	0	50	N 66 continuous	
Total		**65**	**65**	**115**		

Source: IHS Chemical estimates.

In 2015, the total nylon 66 resin capacity was 65 thousand metric tons in the Middle East.

- Nilit in Israel is the largest producer of nylon 66 resins with a capacity of 50 thousand metric tons. About half of Nililt's production is for internal consumption for fibers; the remainder is for the merchant market. Nilit's subsidiary companies in Italy (Euronil), Germany (Frisetta), and China (Nilit) produce nylon compounds.
- The latest addition to the region's nylon 66 capacity is Saudi Polymers' 50 thousand metric ton plant in Al Jubail, which is expected to be operational in 2016. Saudi Polymers is owned by Jubail Chevron Phillips, a 50/50 joint venture of Saudi Industrial Investment Group (SIIG) and Chevron Phillips. The joint venture owns nine downstream nylon conversion plants, operating under the name Petrochemical Conversion Company (PCC).

Salient statistics

Nylon 6

The following table presents Middle Eastern supply/demand for nylon 6:

Middle Eastern supply/demand for nylon 6
(thousands of metric tons)

	Annual capacity	Operating rate (percent)	Production	Imports	Exports	Actual consumption
1990	16	59	9	-	-	-
1995	16	106	17	1	-	-
2000	57	87	50	37	4	35
2001	42	93	39	12	5	-
2002	42	81	34	12	5	-
2003	42	70	29	22	5	-
2004	37	111	41	37	7	7
2005	32	75	24	38	6	6
2006	32	68	22	36	6	6
2007	32	64	20	41	2	11
2008	32	39	13	55	4	16
2009	16	29	5	44	3	10
2010	16	18	3	63	7	14
2011	16	31	5	68	5	20
2012	16	31	5	68	7	20
2013	16	13	2	57	9	21
2014	30	40	12	50	10	21
2015	39	36	14	56	16	23

Source: IHS Chemical estimates.

In 2015, the Middle East produced 14 thousand metric tons of nylon 6 at an operating rate of 36%. Imports provided most of the nylon 6 supply.

Nylon 66

The following table presents Middle Eastern supply/demand for nylon 66:

Middle Eastern supply/demand for nylon 66
(thousands of metric tons)

	Annual capacity	Operating rate (percent)	Production	Imports	Exports	Actual consumption
1990	35	33	12	2	1	1
1995	35	121	42	14	2	-
2000	67	47	31	20	14	-
2001	67	39	26	23	8	-
2002	67	42	28	35	10	-
2003	67	53	36	26	13	-
2004	67	62	41	28	17	5
2005	82	57	47	24	20	4
2006	65	66	43	31	19	4
2007	65	64	42	36	20	5
2008	65	74	48	33	23	10
2009	65	58	38	35	14	5
2010	65	80	52	45	24	15
2011	65	83	54	43	24	17
2012	65	81	52	44	20	18
2013	65	72	47	43	13	18
2014	65	91	59	41	22	19
2015	65	79	51	44	13	21

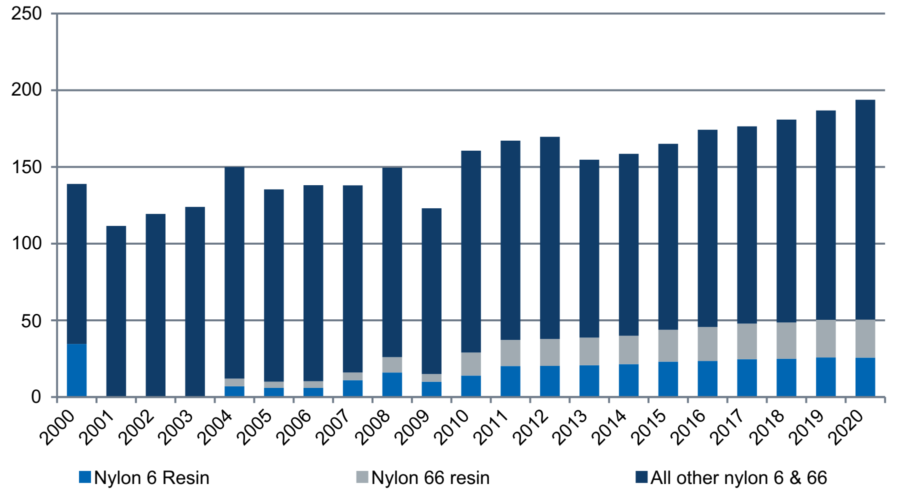
Source: IHS Chemical estimates.

In 2015, the Middle East produced 51 thousand metric tons of nylon 66 at an operating rate of 79%. Increasing capacity and production are expected to allow for increased nylon 66 exports; the Middle East is expected to become a net exporter of nylon 66 in the next five years. The operating rates are also expected to increase, in line with the rise in production.

Consumption

The Middle East consumed about 165 thousand metric tons of nylon 6 and 66 in 2015. Nylon resin applications consumed about 26% of the total; the remainder was consumed in fiber applications. In the last five years, total consumption of nylon has grown at only about 0.6% per year because the use of nylon in fiber applications has declined. Nylon resin applications have been growing at a healthy rate of about 8.6% per year.

Middle Eastern consumption of nylon by application



Notes: Data are in thousands of metric tons
Source: IHS Chemical

The following table presents Middle Eastern consumption of nylon 6 resins:

Middle Eastern consumption of nylon 6
(thousands of metric tons)

	Automotive	Electrical and electronic	Appliances	Film and coating	Wire and cable	Consumer	Industrial/ machinery	Other	Total
2005	3	-	1	-	-	-	1	1	6
2006	3	-	1	-	-	-	1	1	6
2007	5	1	1	-	-	1	2	1	11
2008	5	2	1	-	-	2	2	4	16
2009	4	1	1	-	-	1	1	2	10
2010	6	1	1	-	-	1	2	3	14
2011	8	1	2	-	-	2	2	5	20
2012	9	1	2	-	-	2	2	4	20
2013	10	1	2	-	-	2	2	5	21
2014	10	1	2	-	-	2	2	5	21
2015	11	1	2	-	-	2	2	5	23
2020	12	1	2	-	-	3	3	5	26
Average annual growth rate (percent)									
2015–20	1.2%	4.4%	4.2%	—	—	2.7%	3.0%	2.7%	2.2%

Source: IHS Chemical estimates.

The following table presents Middle Eastern consumption of nylon 66 resins:

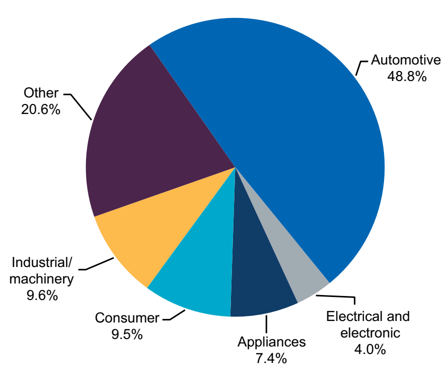
Middle Eastern consumption of nylon 66
(thousands of metric tons)

	Automotive	Electrical and electronic	Appliances	Film and coating	Wire and cable	Consumer	Industrial/ machinery	Other	Total
2005	4	-	-	-	-	-	-	-	4
2006	4	-	-	-	-	-	-	-	4
2007	5	-	-	-	-	-	-	-	5
2008	5	1	2	-	-	-	1	2	10
2009	3	1	1	-	-	-	-	1	5
2010	6	3	3	-	-	1	1	2	15
2011	7	3	3	-	-	1	1	3	17
2012	6	3	3	-	-	1	2	3	18
2013	7	3	2	-	-	1	2	3	18
2014	7	3	2	-	-	1	2	3	19
2015	8	3	3	-	-	1	2	4	21
2020	9	3	3	-	-	1	3	6	25
Average annual growth rate (percent)									
2015–20	1.2%	4.2%	4.3%	—	—	3.4%	3.1%	7.2%	3.6%

Source: IHS Chemical estimates.

The following charts show the consumption of nylon resins by end use for nylon 6 and nylon 66. Consumption of nylon resins is dominated by the automotive applications in the Middle East.

Middle Eastern consumption of nylon 6 by end use—2015



Source: IHS Chemical

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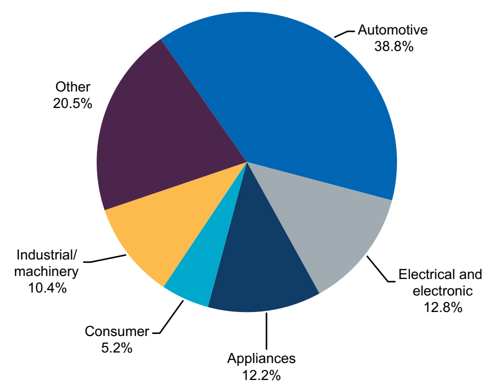
Middle Eastern consumption of nylon 66 by end use—2015



Source: IHS Chemical

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The demand for nylon resin is well-balanced across the market segments; the region is not a traditional resin convertor, although it has the long-term ambition to develop employment in the region. In the past, the Middle East has relied more on building chemical production capacity and exporting the output.

The Middle East produced about 2.6 million vehicles in 2015, a large portion of which was in Turkey. Automotive applications are the largest market for nylon resins, with 44% of 2015 consumption.

Automotive applications consumed a total of 19 thousand metric tons of nylon resins in 2015. The nylon type segmentation was about 11 thousand metric tons (58%) for nylon 6 and 8 thousand metric tons (42%) for nylon 66. This market is expected to increase at about 1% per year through the forecast period.

Appliances, electrical and electronic, and industrial/machinery applications each accounted for about 3–4 thousand metric tons in 2015 (8–10%). Appliances and electrical/electronic uses will grow at even faster rates in the next five years, but all from a very small base. Overall consumption is expected to grow at 2.8% in 2015–20, reaching about 51 thousand metric tons by 2020.

Trade

The Middle East is a net importer of both types of nylon resins. In 2015, the region imported around 49 thousand metric tons of nylon 6, compared to exports of about 16 thousand metric tons. The domestic market is mainly served by imports.

In 2015, 44 thousand metric tons of nylon 66 were imported and 13 thousand metric tons were exported. By 2020, with new capacity in place, the region is expected to become a net exporter of nylon 66.

Africa

There is no production of nylon resins in Africa. All the demand in the region is supplied by imports. There is no anticipated production in the next five years.

Producing companies

There is no production of nylons in Africa. The domestic demand is completely import dependent for both types of nylons.

Salient statistics

Nylon 6

The following table presents African supply/demand for nylon 6:

African supply/demand for nylon 6 (thousands of metric tons)						
	Annual capacity	Operating rate (percent)	Production	Imports	Exports	Actual consumption
1990	-	-	-	1	-	-
1995	-	-	-	14	-	-
2000	-	-	-	20	-	-
2001	-	-	-	17	-	-
2002	-	-	-	11	-	-
2003	-	-	-	8	-	-
2004	-	-	-	2	-	-
2005	-	-	-	2	-	-
2006	-	-	-	3	-	3
2007	-	-	-	5	-	3
2008	-	-	-	5	-	4
2009	-	-	-	2	-	1
2010	-	-	-	4	-	4
2011	-	-	-	6	-	6
2012	-	-	-	7	-	7
2013	-	-	-	6	-	5
2014	-	-	-	5	-	5
2015	-	-	-	5	-	5

Source: IHS Chemical estimates.

The small domestic demand in the region is supplied by imports, with South Africa being the main recipient.

Nylon 66

The following table presents African supply/demand for nylon 66:

African supply/demand for nylon 66 (thousands of metric tons)						
	Annual capacity	Operating rate (percent)	Production	Imports	Exports	Actual consumption
1990	-	-	-	31	-	-
1995	-	-	-	26	-	-
2000	-	-	-	19	-	-
2001	-	-	-	17	-	-
2002	-	-	-	24	-	8
2003	-	-	-	20	-	9
2004	-	-	-	23	-	3
2005	-	-	-	22	-	6
2006	-	-	-	24	-	10
2007	-	-	-	23	-	10
2008	-	-	-	17	-	4
2009	-	-	-	10	-	7
2010	-	-	-	12	-	12
2011	-	-	-	13	-	13
2012	-	-	-	13	-	13
2013	-	-	-	15	-	14
2014	-	-	-	15	-	15
2015	-	-	-	15	-	16

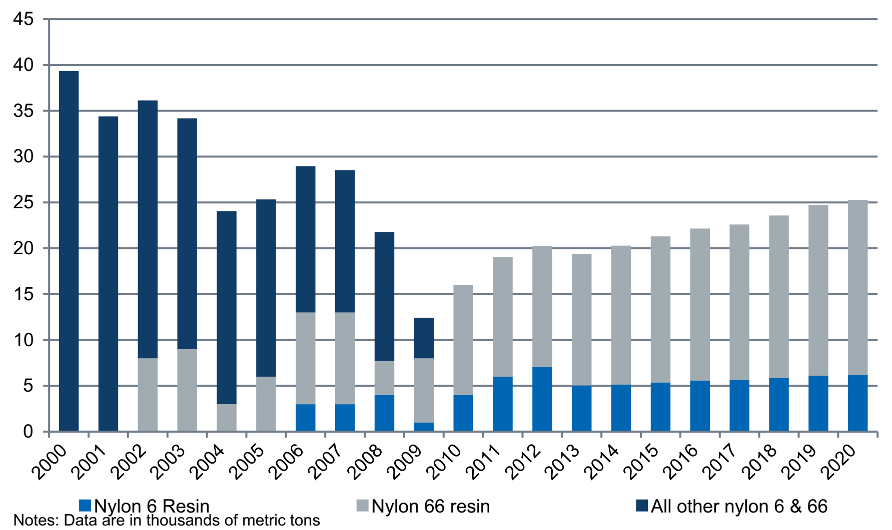
Source: IHS Chemical estimates.

In the last five years, more than 90% of the nylon 66 imported into Africa has been consumed in engineering applications.

Consumption

Africa consumed about 21 thousand metric tons of nylon 6 and 66 in 2015. Nylon resin applications consumed 100% of the total, with no nylon consumed in fiber applications. In the last five years, consumption of nylon resin in the region has grown at about 5.9% per year.

African consumption of nylon by application



Notes: Data are in thousands of metric tons

Source: IHS Chemical

The following table presents African consumption of nylon 6 resins:

African consumption of nylon 6
(thousands of metric tons)

	Automotive	Electrical and electronic	Appliances	Film and coating	Wire and cable	Consumer	Industrial/ machinery	Other	Total
2005	-	-	-	-	-	-	-	-	-
2006	2	-	-	-	-	-	-	1	3
2007	2	-	-	-	-	-	-	1	3
2008	2	-	-	-	-	-	-	2	4
2009	-	-	-	-	-	-	-	1	1
2010	2	-	-	-	-	-	-	2	4
2011	2	-	1	-	-	-	1	2	6
2012	2	-	1	-	-	1	1	2	7
2013	2	-	-	-	-	-	1	2	5
2014	2	-	-	-	-	-	1	2	5
2015	2	-	-	-	-	-	1	2	5
2020	3	-	-	-	-	-	1	2	6
Average annual growth rate (percent)									
2015–20	3.4%	—	—	—	—	—	3.0%	2.0%	2.8%

Source: IHS Chemical estimates.

The following table presents African consumption of nylon 66 resins:

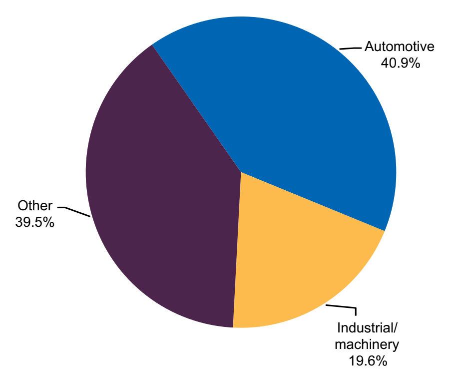
African consumption of nylon 66
(thousands of metric tons)

	Automotive	Electrical and electronic	Appliances	Film and coating	Wire and cable	Consumer	Industrial/ machinery	Other	Total
2005	5	-	-	-	-	-	1	-	6
2006	6	-	-	-	-	-	1	3	10
2007	5	-	-	-	-	-	1	4	10
2008	3	-	-	-	-	-	-	1	4
2009	2	-	-	-	-	-	1	4	7
2010	4	2	-	-	-	-	1	5	12
2011	5	2	1	-	-	1	2	2	13
2012	6	2	1	-	-	1	1	2	13
2013	7	2	1	-	-	1	1	2	14
2014	8	2	1	-	-	1	1	2	15
2015	8	2	1	-	-	1	1	2	16
2020	10	3	1	-	-	1	1	2	19
			Average annual growth rate (percent)						
2015–20	3.9%	4.9%	5.0%	—	—	3.7%	3.1%	1.6%	3.7%

Source: IHS Chemical estimates. © 2016 IHS

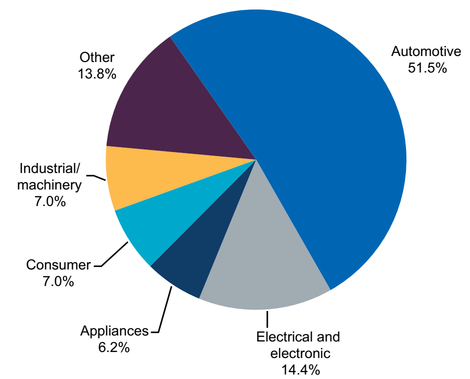
The following charts show consumption of nylon resin by end use for nylon 6 and nylon 66 resins. African consumption of nylon 6 and nylon 66 is dominated by the automotive applications.

African consumption of nylon 6 by end use—2015



Source: IHS Chemical © 2016 IHS

African consumption of nylon 66 by end use—2015



Source: IHS Chemical © 2016 IHS

Automotive

The main driver of nylon resin demand in the region is automotive applications. In 2015, the region produced about 0.9 million vehicles or about 1% of the total vehicle production in the world. The total nylon resin consumption was about 10 thousand metric tons, with nylon 66 accounting for nearly 80% of the total. In the next five years, African vehicle production is forecast to grow at about 4% per year. Consumption of nylon resin is expected to grow comparable rate of around 3.8% per year and reach nearly 13 thousand metric tons by 2020.

Other

Other applications consumed much smaller volumes (1–3 thousand metric tons) in 2015, and are expected to increase at 3–5% per year.

Trade

Africa does not produce nylon resins and so must import all of its demand. In 2015, Africa imported about 5 thousand metric tons of nylon 6 and 15 thousand metric tons of nylon 66. Western Europe (71%) is the main supplier of nylon to the region.

Imports will increase with the growth forecast for these products, as no local production is expected through 2020.

Indian Subcontinent

India produces only nylon 6 and no capacity additions are expected in the near future. India imports a small volume of nylon 66 to address its domestic demand in automotive and electrical applications.

Producing companies

The following table presents the producers of nylon 6 in India:

Indian Subcontinent producers of nylon 6
(thousands of metric tons)

Company	Plant location	Average annual capacity 2013	2015	2020	Raw material and and process	Remarks
Century Enka	Pune	50	50	50	N 6 continuous	
GSFC	Vadodara	7	7	7	N 6 continuous	
Gujarat Nylons Ltd.	Surat	9	9	9	N 6 continuous	
Modipon	Ghaziabad	9	9	9	N 6 continuous	
Nirlon SynFib.&Chem	Bombay	5	5	5	N 6 continuous	Estimated capacity.
SRF	Malanpur	25	25	25	N 6 continuous	
	Manali	26	26	26	N 6 continuous	
Total		**131**	**131**	**131**		

Source: IHS Chemical estimates.

In the Indian Subcontinent, India is the only producing region. The total nylon 6 resin capacity was about 131 thousand metric tons in 2015. There are six producers in India with the largest producers being SRF (51 thousand metric tons) and Century Enka (50 thousand metric tons). There have been no capacity additions announced in the region, but it is likely that additional capacity will be added to meet rising demand.

There is no capacity or production of nylon 66 in India.

Salient statistics

Nylon 6

The following table presents Indian Subcontinent supply/demand for nylon 6:

Indian Subcontinent supply/demand for nylon 6 (thousands of metric tons)						
	Annual capacity	Operating rate (percent)	Production	Imports	Exports	Actual consumption
1990	-	-	5	-	-	-
1995	-	-	114	7	-	31
2000	114	74	84	13	-	14
2001	114	83	94	16	-	27
2002	114	85	97	18	-	28
2003	104	94	98	15	-	27
2004	109	93	101	14	-	26
2005	134	77	103	10	-	24
2006	107	100	107	15	-	27
2007	107	105	113	16	-	26
2008	107	103	111	20	-	35
2009	123	80	98	27	-	33
2010	131	77	100	42	-	39
2011	131	70	92	57	-	41
2012	131	69	90	53	2	44
2013	131	63	83	77	-	43
2014	131	63	83	99	9	44
2015	131	55	72	115	6	47

Source: IHS Chemical estimates.

The Indian Subcontinent produced 72 thousand metric tons of nylon 6 in 2015 at an operating rate of 55%. Imports supplied about 60% of consumption for nylon resins and fibers.

The reduction in nylon capacity in 2006 led to temporarily high operating rates for several years, until the capacity was increased in 2009. No capacity additions are expected in the next five years.

Consumption of nylon 6 is increasing in India, requiring higher production volumes, and thus operating rates are expected to improve. All the production and imports are directed toward the domestic market in India; there is no known consumption in the other countries in the region.

Nylon 66

The following table presents Indian Subcontinent supply/demand for nylon 66:

Indian Subcontinent supply/demand for nylon 66
(thousands of metric tons)

	Annual capacity	Operating rate (percent)	Production	Imports	Exports	Actual consumption
1990	-	-	-	-	-	-
1995	-	-	-	-	-	-
2000	-	-	-	-	-	-
2001	-	-	-	-	-	-
2002	-	-	-	-	-	-
2003	-	-	-	-	-	-
2004	-	-	-	-	-	-
2005	-	-	-	3	-	3
2006	-	-	-	2	-	2
2007	-	-	-	3	-	3
2008	-	-	-	5	-	5
2009	-	-	-	6	-	6
2010	-	-	-	10	-	10
2011	-	-	-	11	-	11
2012	-	-	-	11	-	11
2013	-	-	-	11	-	11
2014	-	-	-	11	-	11
2015	-	-	-	11	-	11

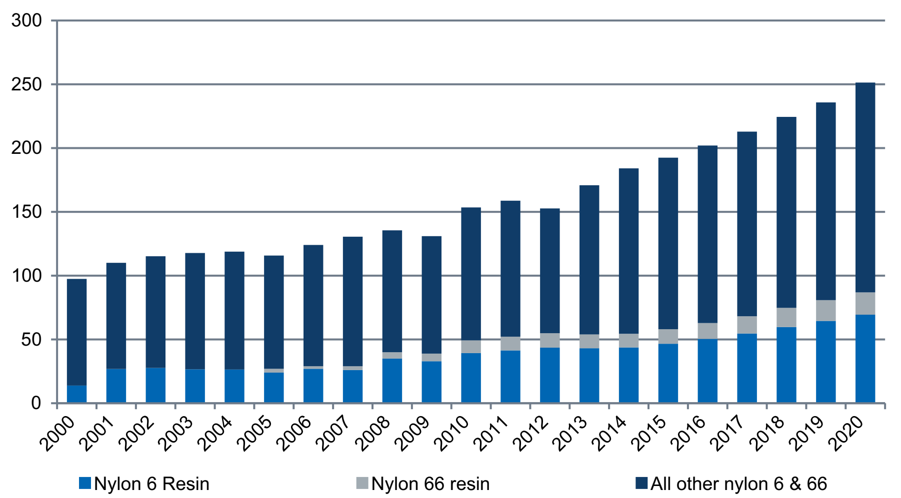
Source: IHS Chemical estimates.

There is no production of nylon 66 in India, so domestic demand is supplied by imports. Most of the nylon 66 is used for engineering applications.

Consumption

The following chart shows that 192 thousand metric tons of nylon 6 and 66 were consumed in the Indian subcontinent in 2015. Nylon resin applications consumed about 30% of the total; the remainder is consumed in fiber applications. In the last five years, total consumption of nylon in the region has been growing at about 4.6% per year, particularly in nylon 6 fiber applications. Nylon resin applications have been growing at a slower rate between 2.7% and 3.5% per year.

Indian Subcontinent consumption of nylon by application



Notes: Data are in thousands of metric tons
Source: IHS Chemical

The following table presents the Indian Subcontinent consumption of nylon 6 resins:

Indian Subcontinent consumption of nylon 6 (thousands of metric tons)									
	Automotive	Electrical and electronic	Appliances	Film and coating	Wire and cable	Consumer	Industrial/ machinery	Other	Total
2005	7	3	5	-	-	2	5	2	24
2006	8	5	5	-	-	2	5	2	27
2007	11	3	6	-	-	1	4	1	26
2008	13	5	7	-	-	2	6	2	35
2009	13	4	6	-	-	2	6	2	33
2010	16	5	7	-	-	2	7	2	39
2011	18	5	7	-	-	2	7	2	41
2012	19	6	7	-	0	2	8	2	44
2013	18	5	7	-	0	2	8	2	43
2014	18	5	7	-	0	3	8	2	44
2015	19	6	8	-	0	3	9	2	47
2020	29	9	11	-	1	4	12	3	69
			Average annual growth rate (percent)						
2015–20	9.3%	9.7%	7.8%	—	8.1%	8.0%	6.4%	4.7%	8.3%

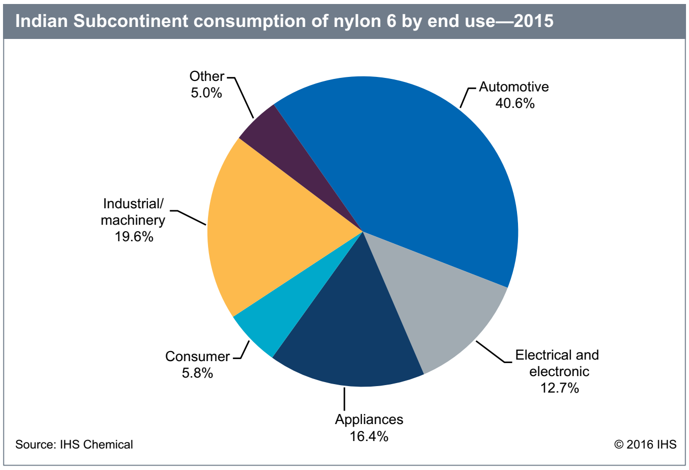
Source: IHS Chemical estimates. © 2016 IHS

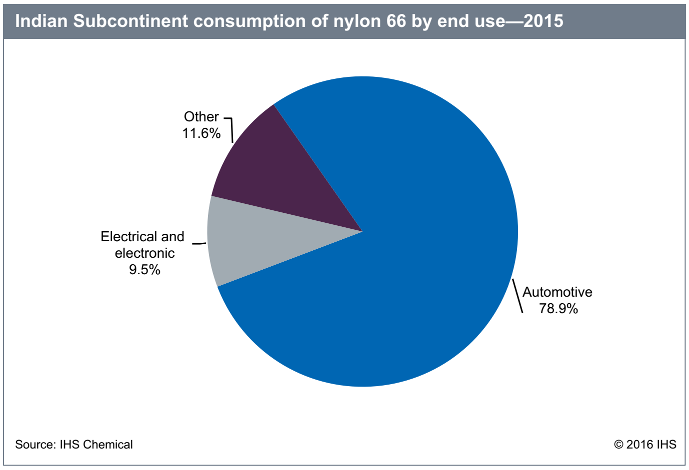
The following table presents the Indian Subcontinent consumption of nylon 66 resins:

Indian Subcontinent consumption of nylon 66 (thousands of metric tons)									
	Automotive	Electrical and electronic	Appliances	Film and coating	Wire and cable	Consumer	Industrial/ machinery	Other	Total
2005	2	1	-	-	-	-	-	-	3
2006	2	-	-	-	-	-	-	-	2
2007	2	1	-	-	-	-	-	-	3
2008	4	1	-	-	-	-	-	-	5
2009	5	1	-	-	-	-	-	-	6
2010	8	1	-	-	-	-	-	1	10
2011	9	1	-	-	-	-	-	1	11
2012	9	1	-	-	-	-	-	1	11
2013	9	1	-	-	-	-	-	1	11
2014	9	1	-	-	-	-	-	1	11
2015	9	1	-	-	-	-	-	1	11
2020	14	2	-	-	-	-	-	2	17
			Average annual growth rate (percent)						
2015–20	9.3%	9.7%	—	—	—	—	—	5.3%	8.9%

Source: IHS Chemical estimates. © 2016 IHS

The following charts show the consumption of nylon resins by end use for nylon 6 and nylon 66. Consumption of nylon 6 and nylon 66 is dominated by automotive applications in the Indian Subcontinent; the next-largest consuming applications are industrial/machinery and appliances, which consume only nylon 6.





Automotive

In 2015, the region produced about 4.4 million vehicles or about 4.8% of the total vehicle production in the world. Total nylon resin consumption in this application was nearly 28 thousand metric tons, with nylon 6 accounting for 68% of the total. In the next five years, regional vehicle production is forecast to grow at about 9.1% per year. As a result, consumption of nylon resin is expected to grow at around 9.0–9.5% per year to reach about 43 thousand metric tons by 2020.

Industrial/machinery

Industrial/machinery applications consumed about 9 thousand metric tons of nylon 6 in 2015. This application is expected to grow at about 6.4% per year in 2015–20, to reach 12 thousand metric tons by 2020.

Other

The next-largest consumption end uses for nylons are appliances and electrical and electronic applications, each of which consumed about 7–8 thousand metric tons of nylon resins in 2105. Appliances consumed only nylon 6 resins and are expected to grow at about 7–8% per year, while electrical/electronic uses consumed mostly nylon 6 and are expected to grow at 9.7% for the next five years.

Trade

India is a net importer of both nylon 6 and nylon 66. India imported about 115 thousand metric tons of nylon 6. India does not produce nylon 66 and so imported 11 thousand metric tons in 2015. The main supplier of nylon resins to India in 2015 was Northeast Asia (56%).

India will have strong demand for these products; hence, imports are expected to grow for both types of nylons with no increase in exports expected in future years.

Northeast Asia

Northeast Asia includes China, Japan, South Korea, and Taiwan. This region has the largest capacity for nylon 6 and the second-largest capacity for nylon 66 in the world, due mainly to China. In addition to having significant nylon production capacity, the Northeast Asian market is growing at a much faster rate than any other region. Even with the high production volumes, the region continues to be a net importer to satisfy local demand.

Production capacity

The total nylon 6 resin capacity was over 4.6 million metric tons in 2015. Northeast Asia is the largest production center for nylon 6 resins and its production levels are increasing owing to higher domestic and global demand.

Northeast Asian capacity for nylon 6 (thousands of metric tons)

	2013	2015	2020
China	2,209	3,234	4,605
Japan	164	144	144
South Korea	298	206	206
Taiwan	956	986	1,136
Total	**3,627**	**4,570**	**6,091**

Source: IHS Chemical estimates. © 2016 IHS

The largest producer of nylon 6 in the region is China, with approximately 3.3 million metric tons or about 71% of the total regional capacity in 2015. China is still growing at a faster pace than the other countries in the region, adding more capacity and in turn production. China added about 1.1 million metric tons of nylon 6 capacity in just two years (2013–15).

Taiwan is the second-largest producer of nylon 6 resins, with a nameplate capacity of 986 thousand metric tons (21% of the regional total) in 2015. Japan has 144 thousand metric tons of nylon 6 and the South Korea has a capacity of 206 thousand metric tons in 2015. The total capacity in the region is expected to rise to 5.7 million metric tons by 2020, which is a 23% increase from the 2015 level.

Northeast Asian capacity for nylon 66 (thousands of metric tons)

	2013	2015	2020
China	336	431	691
Japan	98	98	98
South Korea	55	55	55
Taiwan	10	13	30
Total	**499**	**597**	**874**

Source: IHS Chemical estimates. © 2016 IHS

The nylon 66 resin capacity was about 597 thousand metric tons in 2015. The total nylon 66 capacity is expected to rise to 874 thousand metric tons by 2020. The largest nylon 66–producing country in Northeast Asia is China with a capacity of 431 thousand metric tons, representing about 72% of the region's capacity.

Salient statistics

Nylon 6

The following table presents Northeast Asian supply/demand for nylon 6:

Northeast Asian supply/demand for nylon 6
(thousands of metric tons)

	Annual capacity	Operating rate (percent)	Production	Imports	Exports	Actual consumption
1990	390	149	579	30	1	103
1995	951	115	1,092	117	77	218
2000	1,652	87	1,441	247	124	371
2001	1,622	93	1,505	174	124	334
2002	1,556	97	1,513	282	161	329
2003	1,561	102	1,586	274	141	382
2004	1,661	97	1,617	373	165	396
2005	1,941	90	1,753	443	250	474
2006	2,204	85	1,881	446	329	503
2007	2,558	76	1,951	563	396	594
2008	2,585	68	1,760	591	410	549
2009	2,681	73	1,957	702	464	545
2010	2,865	79	2,263	662	450	594
2011	3,096	72	2,238	697	450	613
2012	3,377	73	2,449	676	482	643
2013	3,627	74	2,676	696	504	672
2014	3,782	70	2,660	663	446	702
2015	4,570	63	2,884	585	411	724

Source: IHS Chemical estimates.

Northeast Asia has the largest capacity for nylon 6 in the world; production was nearly 2.9 million metric tons in 2015, accounting for nearly 60% of the global total. In the last five years, regional production of nylon 6 has grown at about 5% per year. Because of increasing demand during the forecast period, regional production is expected to increase by another 20% by 2020, to reach nearly 3.5 million metric tons.

Nylon 66

The following table presents Northeast Asian supply/demand for nylon 66:

Northeast Asian supply/demand for nylon 66
(thousands of metric tons)

	Annual capacity	Operating rate (percent)	Production	Imports	Exports	Actual consumption
2000	93	158	147	104	39	61
2001	106	103	110	142	28	92
2002	146	62	90	172	39	94
2003	146	74	109	226	75	143
2004	152	100	153	263	83	172
2005	204	83	170	272	68	207
2006	226	80	180	392	100	298
2007	244	86	210	427	109	318
2008	323	64	206	439	120	316
2009	331	69	230	326	113	279
2010	360	81	293	428	172	328
2011	422	82	345	413	173	342
2012	474	67	319	467	181	363
2013	499	67	332	503	194	384
2014	519	69	359	527	211	406
2015	597	68	406	498	208	419

Source: IHS Chemical estimates.

Total capacity for nylon 66 is on a much smaller scale than nylon 6 capacity in Northeast Asia, at about 597 thousand metric tons in 2015. Production of nylon 66 resins was about 406 thousand metric tons in 2015, which resulted in an overall operating rate of 68%.

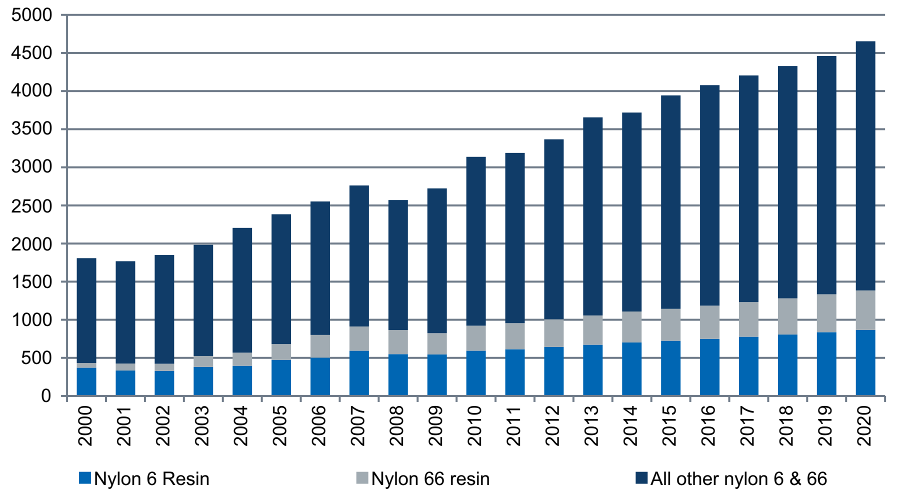
Northeast Asia imports more nylon 66 than it produces. In 2015, total regional demand for nylon 66 was about 696 thousand metric tons, with about 60% consumed in nylon resin applications.

By 2020, production is estimated to be about 601 thousand metric tons to result in an operating rate of nearly 69%. After trade, the volume consumed by nylon resin applications is expected to increase to about 64% of total demand.

Consumption

The following chart shows about 4 million metric tons of nylon 6 and 66 were consumed in Northeast Asia in 2015. Nylon resin applications consumed about 28% of the total; the remainder is consumed in fiber applications. In the last five years, total consumption of nylon in the region has been growing at about 4.7% per year, particularly in fiber applications in China. Nylon 66 resin applications have been growing at a faster rate of about 5% per year, while nylon 6 resin applications have been growing at a slightly slower rate of 4.1% per year.

Northeast Asian consumption of nylon by application



Notes: Data are in thousands of metric tons
Source: IHS Chemical

The following table presents Northeast Asia consumption of nylon 6 resins:

Northeast Asian consumption of nylon 6
(thousands of metric tons)

	Automotive	Electrical and electronic	Appliances	Film and coating	Wire and cable	Consumer	Industrial/ machinery	Other	Total
2005	64	56	46	105	-	63	108	32	474
2006	70	60	49	111	-	67	113	33	503
2007	87	77	59	121	-	80	129	41	594
2008	83	70	54	124	-	65	117	36	549
2009	86	69	55	122	-	66	116	31	545
2010	103	73	58	127	-	75	123	35	594
2011	102	77	64	129	-	78	127	37	613
2012	110	83	68	130	-	82	133	38	643
2013	116	88	73	130	-	86	139	40	672
2014	122	93	78	131	-	91	146	41	702
2015	121	98	82	131	-	97	152	43	724
2020	138	133	110	134	-	121	183	49	867
				Average annual growth rate (percent)					
2015–20	2.6%	6.2%	6.2%	0.4%	—	4.6%	3.7%	2.5%	3.7%

Source: IHS Chemical estimates.

The following table presents Northeast Asia consumption of nylon 66 resins:

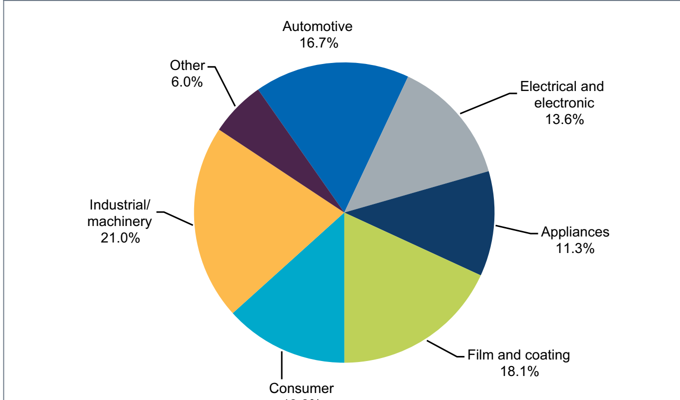
Northeast Asian consumption of nylon 66
(thousands of metric tons)

	Automotive	Electrical and electronic	Appliances	Film and coating	Wire and cable	Consumer	Industrial/ machinery	Other	Total
2005	78	40	26	8	-	13	32	10	207
2006	94	55	46	9	-	29	50	15	298
2007	108	57	48	9	-	31	50	15	318
2008	108	56	47	9	-	30	50	16	316
2009	103	49	44	8	-	24	39	12	279
2010	126	58	49	9	-	29	43	14	328
2011	126	62	54	9	-	31	45	14	342
2012	135	67	58	10	-	33	46	15	363
2013	143	71	62	10	-	34	48	15	384
2014	151	76	66	10	-	36	51	16	406
2015	151	81	70	10	-	38	53	17	419
2020	172	109	95	10	-	48	63	20	518
				Average annual growth rate (percent)					
2015–20	2.7%	6.3%	6.4%	0.6%	—	4.5%	3.6%	3.8%	4.3%

Source: IHS Chemical estimates.

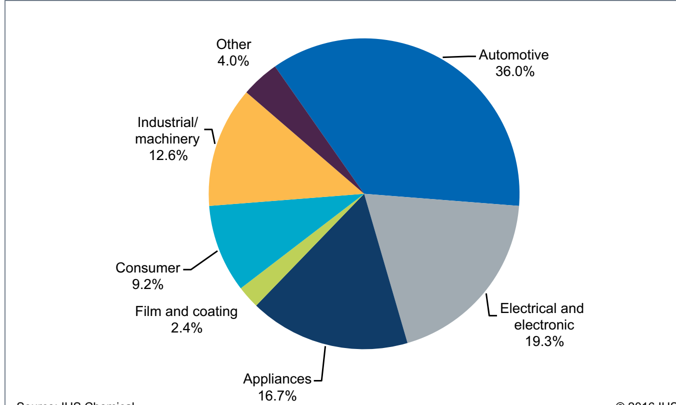
The following charts show the consumption of nylon resins by end use for nylon 6 and nylon 66. The consumption of nylon resins is dominated by the automotive applications in Northeast Asia; the next-largest consuming applications are industrial/machinery and electrical/electronics. Film and coating and appliances are also strong consumers of nylon resins in the region.

Northeast Asian consumption of nylon 6 by end use—2015



Source: IHS Chemical © 2016 IHS

Northeast Asian consumption of nylon 66 by end use—2015



Source: IHS Chemical © 2016 IHS

Northeast Asia participates actively across the entire range of end-use market segments for nylon resins, except wire and cable applications.

Automotive

In 2015, the region produced about 37.9 million vehicles or about 41.7% of the total vehicle production in the world. The region is the largest vehicle producer in the world with strong participation from Japan and South Korea, and out-performs North America, Western Europe, and Central Europe combined.

The total nylon consumption in this application was about 272 thousand metric tons in 2015, with nylon 66 accounting for 55% of the total. In the next five years, Northeast Asian vehicle production is forecast to grow at about 3.1% per year. As a result, consumption of nylon resins for automotive applications is expected to grow at around 2.6% per year, to reach 310 thousand metric tons by 2020.

Industrial/machinery

Industrial and machinery applications consumed 205 thousand metric tons of nylon resins in 2015. Nylon 6 accounts for about 152 thousand metric tons, or 74% of the nylon resins consumed in this application. In the next five years, this application is expected to grow at about 3.7% per year and reach about 246 thousand metric tons by 2020.

Electrical and electronic

Electrical and electronic applications consumed 179 thousand metric tons of nylon resins in 2015. Nylon 6 accounts for about 98 thousand metric tons, or about 55% of the nylon resins consumed in this application. In the next five years, this application is expected to grow at about 6.2% per year and reach about 242 thousand metric tons by 2020.

Appliances

Appliance applications consumed 152 thousand metric tons of nylon resins in 2015. Nylon 6 accounts for about 82 thousand metric tons, or about 54% of the nylon resins consumed in this application. In the next five years, this application is expected to grow at about 6.2% per year and reach about 205 thousand metric tons by 2020.

Film and coating

Film and coating applications consumed 141 thousand metric tons of nylon resins in 2015. Nylon 6 accounts for about 131 thousand metric tons, or about 93% of the nylon resins consumed in this application. In the next five years, this application is expected to grow at only about 0.4% per year and reach about 144 thousand metric tons by 2020.

Other

The remaining applications consumed a total of 195 thousand metric tons of nylon resins in 2015, with nylon 6 accounting for 140 thousand metric tons or 72% of the total. In the next five years, these applications are expected to grow at about 4% and reach 237 thousand metric tons by 2020, split between nylon 6 (71%) and nylon 66 (29%).

Trade

Northeast Asia is a net importer of nylon 6 and nylon 66 resins. In 2015, the region imported 585 thousand metric tons and exported 411 thousand metric tons of nylon 6. With the anticipated increase in regional capacity and production, imports are expected to decline in the next five years, as the region becomes more self-sufficient.

Exports of nylon 6 are expected to level off in the next five years. The region is more geared toward addressing domestic demand, and thus exports are not expected to increase drastically even with an increase in production.

The region imported 498 thousand metric tons and exported 208 thousand metric tons of nylon 66 in 2015. The trade for nylon 66 will not undergo any major changes, as production is expected to increase in line with future demand.

China

China is the largest global producer of nylon 6 and the third-largest producer of nylon 66 after the United States and Western Europe. Chinese consumption of nylons is still growing at higher-than-average rates, and the country is a major net importer of both resins.

Capacity and production of nylon resin has been increasing rapidly because automotive and electrical/electronic parts manufacturing and molding has moved from Japan and Western countries to China. The growth of global nylon 6 demand has also been shaped by the migration of synthetic fiber and durable finished goods production from North America and other developed regions to China; hence, Northeast Asia has become the largest nylon 6–consuming region.

China produced about 32% of the world's total nylon 6 and nylon 66 resins and more specifically 41% of the world's nylon 6 in 2015. China produces less caprolactam (the feedstock for nylon 6) than it consumes and so in recent years, it has been a major importer of caprolactam. This has had an impact on the profitability of nylon 6 because:

- Caprolactam supply has been relatively tight with respect to nylon 6 production. In recent years, caprolactam plants have been operating at high rates and this has resulted in a higher price for caprolactam for Chinese nylon 6 producers.
- However, China is building caprolactam capacity to meet its domestic demand; China, moving toward self-sufficiency, plans to add approximately 1.4 million metric tons of caprolactam capacity by 2020.
- Therefore, China is expected to reduce the volume of caprolactam it imports. Because many nylon 6 producers in the rest of Asia also rely on purchased caprolactam, this will assist their profitability too.

Producing companies

The total nylon 6 resin capacity in China is estimated at nearly 3.2 million metric tons in 2015. In 2010, it was just under 1.5 million metric tons. China's production of nylon 6 resin is large and still growing.

Chinese producers of nylon 6
(thousands of metric tons)

Company	Plant location	Average annual capacity 2013	2015	2020	Raw material and and process	Remarks
Baling PC	Yueyang	36	36	36	N 6 continuous	
	Yueyang	20	20	20	N 6 continuous	
BASF SE	Caojing	0	100	100	N 6 continuous	Includes 60 thousand metric tons of nylon 6 and 40 thousand metric tons of nylon 6/66.
Beijing Huayinglun	Beijing	8	8	8	N 6 continuous	
Changsha Nylon Plant	Changsha	4	4	4	N 6 continuous	
Changshu Union Plast.	Changshu	1	1	1	N 6 continuous	
CHTC Sinofiber (Wuxi)	Wuxi	50	50	50	N 6 continuous	
CNCEC	Nanchong	0	0	100	N 6 continuous	
DSM Eng. Plastics	Jiangyin	50	50	50	N 6 continuous	
Fujian Jinjiang Tech.	Changle	50	50	50	N 6 continuous	
	Changle	50	50	50	N 6 continuous	
	Changle	100	100	100	N 6 continuous	
Fujian Zhongjin NM	Putian	0	58	100	N 6 continuous	Fujin Jinjiang Group.
	Putian	0	0	150	N 6 continuous	
Gaoyao Nylon Plant	Gaoyao	8	8	8	N 6 continuous	
Guilin Hongwei	Guilin	3	3	3	N 6 continuous	
Hangzhou B. Peacock	Hangzhou	3	3	3	N 6 continuous	
Hangzhou Dikai	Hangzhou	30	30	30	N 6 continuous	
Hangzhou Hangding	Hangzhou	0	80	80	N 6 continuous	Uhde Inventa-Fischer.
Hangzhou Yongchang	Hangzhou	0	50	85	N 6 continuous	
Hebei Xinhe Nylon	Xinhe	2	2	2	N 6 continuous	
Hefei Textile Fiber	Hefei	2	2	2	N 6 continuous	
Hengli	Nantong	25	25	25	N 6 continuous	
Hubei Xianning	Xianning	5	5	5	N 6 continuous	
Hunan Jinbo ChemFib	Changde	6	35	35	N 6 continuous	
	Changde	5	15	15	N 6 continuous	
	Changde	0	35	35	N 6 continuous	
Indewin Fiber	Wujiang City	0	40	40	N 6 continuous	
Jiangsu Haiyang CF	Taizhou	13	13	13	N 6 continuous	
	Taizhou	23	23	23	N 6 continuous	
	Taizhou	0	3	35	N 6 continuous	
	Taizhou	0	23	35	N 6 continuous	
Jiangsu Hongdou	Wuxi	12	12	12	N 6 continuous	
Jiangsu Hongsheng	Nantong	0	70	100	N 6 continuous	
	Nantong	0	0	100	N 6 continuous	
Jiangsu Jiangshanhong	Nantong	0	38	50	N 6 continuous	
Jiangsu Ruimeifu	Danyang	25	25	25	N 6 continuous	Textile filament.
	Danyang	25	25	25	N 6 continuous	Textile filament.
	Danyang	25	25	25	N 6 continuous	
Jiangsu Tianlun Syn.	Taizhou	8	8	8	N 6 continuous	
Jiangsu Weida	Wuxi	36	36	36	N 6 continuous	
Jiangsu Yongtong	Nantong	0	70	80	N 6 continuous	A 120 thousand metric ton unit is planned.
Jiangxi Tailong	Jiangxi	3	3	3	N 6 continuous	
Jiangyin Qiangli	Wuxi	15	15	15	N 6 continuous	Industrial filament.
	Wuxi	30	30	30	N 6 continuous	Industrial filament.
Jiangyin Xiangda	Jiangyin	1	1	1	N 6 continuous	
Jinzhou SynFib	Jinzhou	4	4	4	N 6 continuous	
Juhua Group	Quzhou	3	3	3	N 6 continuous	
Kaiping Polyester	Kaiping	12	12	12	N 6 continuous	
Liheng Changle	Changle	80	80	80	N 6 continuous	Textile filament.
	Changle	50	50	50	N 6 continuous	Textile filament.

Chinese producers of nylon 6 (continued)
(thousands of metric tons)

Company	Plant location	Average annual capacity 2013	2015	2020	Raw material and and process	Remarks
	Changle	50	50	50	N 6 continuous	
	Changle	0	50	60	N 6 continuous	Semi dull.
	Changle	0	45	60	N 6 continuous	Semi dull.
	Changle	0	15	30	N 6 continuous	Bright.
	Changle	0	10	30	N 6 continuous	Full dull.
Luxi Chemical	Liaocheng	0	18	35	N 6 continuous	Bright.
	Liaocheng	0	0	35	N 6 continuous	
Nantong Wenfeng	Nantong	25	100	100	N 6 continuous	
Ningbo Hengrun	Zhejiang	50	50	50	N 6 continuous	
Ningbo Shunlong	Ningbo	20	20	20	N 6 continuous	Textile filament.
Putian Wende	Putian	3	3	3	N 6 continuous	
Qingdao Kangwei	Qingdao	15	15	15	N 6 continuous	
Qingdao Lianchuang	Qingdao	19	19	19	N 6 continuous	Tire cord.
Qingdao Zhongda	Qingdao	6	6	6	N 6 continuous	
RadiciPlastics	Suzhou	10	10	10	N 6 continuous	
Shandong Anda	Leling	13	13	13	N 6 continuous	Industrial filament.
	Leling	25	25	25	N 6 continuous	Textile filament.
Shandong Fangming	Dongming	33	50	50	N 6 continuous	Bright.
	Dongming	0	11	15	N 6 continuous	
Shandong Shifeng	Liaocheng	15	15	15	N 6 continuous	
	Liaocheng	0	23	35	N 6 continuous	Industrial filament.
	Liaocheng	15	15	15	N 6 continuous	Industrial filament.
	Liaocheng	30	30	30	N 6 continuous	Industrial filament.
Shandong Xiangyu	Jining	30	30	30	N 6 continuous	Industrial filament.
	Jining	10	10	10	N 6 continuous	Industrial filament.
	Jining	30	30	30	N 6 continuous	Industrial filament.
	Jining	0	30	30	N 6 continuous	
Shanghai No 9 Fiber	Shanghai	10	10	10	N 6 continuous	
Shanghai Rongyang CF	Shanghai	6	6	6	N 6 continuous	
Shenma Chemical	Pingdingshan	0	0	60	N 6 continuous	
Shijiazhuang Chemf.	Shijiazhuang	25	25	25	N 6 continuous	
Shijiazhuang Jinqi	Shijiazhuang	20	20	20	N 6 continuous	
Shunde Nylon	Shunde	7	7	7	N 6 continuous	
Sichuan Nanchong	Nanchong	5	5	5	N 6 continuous	
Sifang New Material	Nantong	0	0	100	N 6 continuous	
Tianchen Yaolong	Changle	0	20	20	N 6 continuous	Bright.
Tianjin Haijing	Tianjin	35	35	35	N 6 continuous	Textile filament.
	Tianjin	14	14	14	N 6 continuous	Textile filament.
Tianjin Synthetic	Tianjin	6	6	6	N 6 continuous	
Wuxi Chang'an Polymer	Wuxi	100	100	100	N 6 continuous	Textile filament.
	Wuxi	40	40	40	N 6 continuous	
Wuxi Mingte	Wuxi	50	50	50	N 6 continuous	Textile filament.
Wuxi Weilida	Wuxi	12	12	12	N 6 continuous	Equipment from the United States.
	Wuxi	36	36	36	N 6 continuous	
	Xishan	12	12	12	N 6 continuous	
Wuxi Xinxin	Wuxi	36	36	36	N 6 continuous	
Xiaoshan Changan	Xishan	20	20	20	N 6 continuous	
Xiaoshan Huatong	Xishan	2	2	2	N 6 continuous	
Xinhe Synthetic Fiber	Xingtai	1	1	1	N 6 continuous	
Xinhui Meida DSM	Xinhui	60	60	60	N 6 continuous	
	Xinhui	135	135	135	N 6 continuous	
Yangquan Coal Industry	Yangquan	0	0	100	N 6 continuous	

Chinese producers of nylon 6 (continued)
(thousands of metric tons)

Company	Plant location	Average annual capacity 2013	2015	2020	Raw material and and process	Remarks
Yantai Huarun Nylon	Yantai	8	8	8	N 6 continuous	
Yueyang PC	Yueyang	50	50	50	N 6 continuous	
	Yueyang	60	60	60	N 6 autoclave	
Zhejiang Chuzhou	Zhejiang	2	2	2	N 6 continuous	
Zhejiang Fangyuan	Tongxiang	15	35	35	N 6 continuous	
	Tongxiang	0	35	35	N 6 continuous	
Zhejiang Hongfu	Xiaoshan	70	70	70	N 6 continuous	
Zhejiang Huajian	Wenzhou	35	35	35	N 6 continuous	Textile filament.
	Wenzhou	35	35	35	N 6 continuous	Textile filament.
Zhejiang Jinyuan New Material	Xiaoshan	0	0	300	N 6 continuous	
Zhejiang Juheshun	Xiaoshan	0	38	65	N 6 continuous	
	Xiaoshan	0	12	35	N 6 continuous	
Zhejiang Mesbon	Xiaoshan	35	35	35	N 6 continuous	Textile filament.
	Xiaoshan	35	35	35	N 6 continuous	
Zhejiang Pinghu	Pinghu	3	3	3	N 6 continuous	
Zhong Lun Su Ye (Fujian)	Quanzhou	0	0	110	N 6 continuous	
Zhongshan Xinhua	Zhongshan	7	7	7	N 6 continuous	
Total		**2,209**	**3,234**	**4,605**		

Source: IHS Chemical estimates.

China is the largest production base for nylon 6 and has over 65 producers in the country. Unlike some other countries, most of the capacities are scattered, with many very small producers (less than 10 thousand metric tons of capacity) and only a few large-scale producers (over 100 thousand metric tons of capacity). The market is very diverse and growing, with escalating capacity and consumption.

- Liheng Changle, with a capacity of 300 thousand metric tons, is the largest producer of nylon 6 in China with about 9.3% to the country's total capacity. In mid-2012, Liheng Changle started up two additional nylon 6 plants at Changle, Fujian Province, adding 100 thousand metric tons of capacity.

- The second-largest producer of nylon 6 is Fujian Jinjiang Tech with an estimated nameplate capacity of 200 thousand metric tons in 2015, which is 6.2% of the total capacity in China. In mid-2012, the company started up a 100 thousand metric ton plant at Changle, Fujian, doubling its nylon 6 capacity.

- The third-largest producer in the region is Xinhui Meida DSM with a total capacity of 195 thousand metric tons in 2015, which is 6.0% of the total capacity.

There continues to be a wave of new capacity additions planned in China. By 2020, the capacity for nylon 6 is expected to reach more than 4.6 million metric tons, which is about a 42% rise from the current nameplate capacity. The following table lists the announced plan for capacities to be added during 2013–18 in China. There are no announced additions beyond 2018 yet, but additional capacity announcements are expected soon.

Chinese capacity additions/expansions for nylon 6
(thousands of metric tons)

Company	Plant location	2013	2014	2015	2016	2017	2018
Baling PC	Yueyang, Hunan	18	-	-	-	-	-
BASF SE	Caojing, Shanghai	-	-	100	-	-	-
CNCEC	Nanchong, Sichuan	-	-	-	100	-	-
Fujian Jinjiang Tech.	Changle, Fujian	100	-	-	-	-	-
Fujian Zhongjin NM	Putian, Fujian	-	-	58	167	25	-
Hangzhou Hangding	Hangzhou, Zhejiang	-	33	47	-	-	-
Hangzhou Yongchang	Hangzhou, Zhejiang	-	-	50	35	-	-
Hunan Jinbo ChemFib	Changde, Hunan	11	56	17	-	-	-
Indewin Fiber	Wujiang City, Jiangsu	-	10	30	-	-	-
Jiangsu Haiyang CF	Taizhou, Jiangsu	-	-	32	38	-	-
Jiangsu Hongsheng	Nantong, Jiangsu	-	5	65	30	50	50
Jiangsu Jiangshanhong	Nantong, Jiangsu	-	-	38	12	-	-
Jiangsu Ruimeifu	Danyang, Jiangsu	15	-	-	-	-	-
Jiangsu Yongtong	Nantong, Jiangsu	-	6	64	10	-	-
Liheng Changle	Changle, Fujian	30	-	120	60	-	-
Luxi Chemical	Liaocheng, Shandong	-	-	18	52	-	-
Nantong Wenfeng	Nantong, Jiangsu	25	75	-	-	-	-
Shandong Fangming	Dongming, Shandong	33	17	11	4	-	-
Shandong Shifeng	Liaocheng, Shandong	-	-	23	12	-	-
Shandong Xiangyu	Jining, Shandong	-	7	22	-	-	-
Shenma Chemical	Pingdingshan, Henan	-	-	-	50	10	-
Shijiazhuang Jinqi	Shijiazhuang, Hebei	11	-	-	-	-	-
Sifang New Material	Nantong, Jiangsu	-	-	-	25	75	-
Tianchen Yaolong	Changle, Fujian	-	2	18	-	-	-
Yangquan Coal Industry	Yangquan, Shanxi	-	-	-	75	25	-
Zhejiang Fangyuan	Tongxiang, Zhejiang	15	55	-	-	-	-
Zhejiang Jinyuan New Material	Xiaoshan, Zhejiang	-	-	-	-	300	-
Zhejiang Juheshun	Xiaoshan, Zhejiang	-	-	38	62	-	-
Zhejiang Mesbon	Xiaoshan, Zhejiang	10	-	-	-	-	-
Zhong Lun Su Ye (Fujian)	Quanzhou, Fujian	-	-	-	110	-	-
Total		**268**	**266**	**751**	**842**	**485**	**50**

Source: IHS Chemical estimates.

It is estimated that approximately 534 thousand metric tons of nylon 6 capacity were added during 2013–14. In 2015, a further 751 thousand metric tons of capacity were added. The following summarizes the major changes:

- In late 2014, Jiangsu Hongsheng started its first 100 thousand metric tons nylon 6 plant at Nantong in the Jiangsu province. A second 100 thousand metric ton plant is expected to start around 2017.
- In 2015, BASF started up a 100 thousand metric ton nylon 6 plant at Caojing, Shanghai.
- In late 2015, Fujian Zhongjin started up its first 100 thousand metric ton nylon 6 plant at Putian in the Fujian Province. In 2016, the company is expected to start up a second 150 thousand metric ton plant at the same location.
- In 2016, Liheng Changle is expected to have its four new nylon 6 plants fully operational with a total capacity of 180 thousand metric tons.
- In 2017, Zhejiang Jinyuan New Material plans to start up a 300 thousand metric ton nylon 6 plant at Xiaoshan in Zheijiang Province.
- Around four other new plants for nylon 6 are also coming onstream by 2016, adding to a total capacity of 200–300 thousand metric tons.

China participates very actively in the dynamics of nylon 6 in the market, having a huge capacity and rising consumption rates.

The following table presents the producers of nylon 66 in China:

Chinese producers of nylon 66
(thousands of metric tons)

Company	Plant location	Average annual capacity 2013	2015	2020	Raw material and process	Remarks
BASF SE	Caojing	0	40	40	N 66 continuous	Nylon 6/66 copolymer.
Fujian Shenma	Quanzhou	8	8	8	N 66 continuous	Former Quanzhou ShiTeng. ETP chip.
	Quanzhou	20	20	20	N 66 continuous	Former Quanzhou ShiTeng. ETP chip.
	Quanzhou	10	10	10	N 66 continuous	
	Quanzhou	0	0	15	N 66 continuous	
Guorui Chemical	Anshan	20	20	20	N 66 continuous	Also 50 thousand metric ton nylon salt capacity.
	Anshan	0	20	20	N 66 continuous	
Haian Nylon Plant	Haian	1	1	1	N 66 continuous	
Hangzhou Dikai	Hangzhou	0	20	30	N 66 continuous	For tire cord.
Huafeng Group	Wenzhou	40	40	40	N 66 continuous	Uhde Inventa-Fischer technology.
	Wenzhou	0	15	20	N 66 continuous	ETP chip.
	Wenzhou	0	0	20	N 66 continuous	ETP chip.
INVISTA	Shanghai	0	0	150	N 66 continuous	
Jiangsu Huayang	Haian	20	20	20	N 66 continuous	
Jiangsu Shenma	Nantong	28	28	28	N 66 continuous	Former Nantong Wenfeng.
	Nantong	25	25	25	N 66 continuous	Former Nantong Wenfeng.
	Nantong	10	10	10	N 66 continuous	
	Nantong	0	0	20	N 66 continuous	
Liaoyang Dongda	Liaoyang	3	3	3	N 66 continuous	
Liaoyang PC	Liaoyang	0	0	0	N 66 continuous	Rhone-Poulenc technology.
	Liaoyang	0	0	0	N 66 continuous	
Nantong Wenfeng	Nantong	0	0	0	N 66 continuous	Nantong Pengfa.
	Nantong	0	0	0	N 66 continuous	Nantong Pengfa. ETP chip.
Quanzhou ShiTeng	Quanzhou	0	0	0	N 66 continuous	ETP chip.
	Quanzhou	0	0	0	N 66 continuous	ETP chip.
Shenma Industrial	Pingdingshan	60	60	60	N 66 continuous	
	Pingdingshan	65	65	65	N 66 continuous	
	Pingdingshan	0	0	40	N 66 continuous	
Shenma PHP	Pingdingshan	3	3	3	N 66 continuous	JV with Shenma and PHP.
Yingkou Yinglong	Yingkou	9	9	9	N 66 continuous	
	Yingkou	14	14	14	N 66 continuous	POY, DTY.
Total		**336**	**431**	**691**		

Source: IHS Chemical estimates. © 2016 IHS

Nylon 66 capacity is much smaller than that for nylon 6 in China. The total nylon 66 resin capacity is estimated at about 431 thousand metric tons in 2015, up from 214 thousand metric tons in 2010.

With new capacity additions for nylon 66 coming onstream, total capacity is expected to increase to about 691 thousand metric tons in 2020. In the last five years, the capacity increase for nylon 66 has been at a slower rate than that for nylon 6. In the next five years, the nylon 6 and nylon 66 capacities are expected to increase at average annual rates of 7.3% and 9.9%, respectively.

Salient statistics

Nylon 6

The following table presents China's supply/demand for nylon 6:

Chinese supply/demand for nylon 6
(thousands of metric tons)

	Annual capacity	Operating rate (percent)	Production	Imports	Exports	Actual consumption
1990	70	103	72	-	-	-
1995	202	91	185	60	3	6
2000	372	90	333	93	2	100
2001	374	129	484	49	1	130
2002	390	125	488	130	3	144
2003	450	124	560	160	3	184
2004	528	110	583	244	8	191
2005	757	88	669	344	9	270
2006	874	80	703	362	1	293
2007	1,138	67	760	499	2	366
2008	1,187	61	723	527	7	338
2009	1,283	71	916	653	6	363
2010	1,457	77	1,116	593	5	390
2011	1,634	71	1,158	612	14	414
2012	1,941	70	1,367	595	16	439
2013	2,209	72	1,599	612	13	469
2014	2,476	68	1,688	551	16	497
2015	3,234	61	1,975	458	25	522

Source: IHS Chemical estimates. © 2016 IHS

The supply and demand scenario in China is constantly changing as more capacity is being added. With the increases in capacity coming a step ahead of projected demand, the operating rates are generally depressed in the country; for the past five years, rates have been in the range of 61–77%. In 2015, production was about 2.0 million metric tons and the resulting operating rate was 61%. The operating rate in 2016 is expected to dip to about 52%.

Even though China has sufficient capacity to produce more nylon 6, it still imported 458 thousand metric tons in 2015, or about 19% of its nylon demand of 2.4 million metric tons. Nylon resin applications consumed about 522 thousand metric tons or 22% of the total.

There are new capacity additions taking place every year in China and by 2020, total production is expected to be over 2.6 million metric tons, an increase of 35% from the 2015 level. As a result of the continuous capacity additions, the average operating rates are expected to remain low.

Nylon 66

The following table presents China's supply/demand for nylon 66:

Chinese supply/demand for nylon 66 (thousands of metric tons)						
	Annual capacity	Operating rate (percent)	Production	Imports	Exports	Actual consumption
1990	-	-	7	-	-	-
1995	14	82	11	1	-	6
2000	47	63	30	41	2	20
2001	47	35	16	85	1	30
2002	47	33	15	92	1	36
2003	47	32	15	96	2	61
2004	53	102	54	95	1	81
2005	105	60	63	99	4	103
2006	150	46	68	196	18	180
2007	168	56	95	235	23	194
2008	211	39	82	248	25	201
2009	197	58	114	188	29	190
2010	214	74	157	222	44	211
2011	276	77	212	193	46	228
2012	316	52	166	253	50	243
2013	336	51	171	276	44	266
2014	356	55	196	280	42	285
2015	431	56	243	259	46	300

Source: IHS Chemical estimates.

The total capacity for nylon 66 is on a much smaller scale than nylon 6 in China, at about 431 thousand metric tons in 2015 (estimated), up from 214 thousand metric tons in 2010. China produced 243 thousand metric tons of nylon 66 in 2015, which resulted in an operating rate of 56%. Again, China imported about 259 thousand metric tons of nylon 66 or nearly 57% of total nylon 66 consumption of 456 thousand metric tons. Nylon resin applications consumed about 300 thousand metric tons or 66% of the total.

In the next five years, Chinese production of nylon 66 is expected to increase, yielding higher operating rates, which will lead to a reduction in imports of nylon 66.

Consumption

China consumed about 3.0 million metric tons of nylon 6 and 66 in 2015. Nylon resin applications consumed about 27% of the total; the remainder was consumed in fiber applications. In the last five years, total consumption of nylon has grown at about 7% per year; in the next five years, consumption growth is expected to be about 3.9% per year due to slower growth in demand for nylon in fiber applications.

The following table presents Chinese consumption of nylon 6 resins:

Chinese consumption of nylon 6
(thousands of metric tons)

	Automotive	Electrical and electronic	Appliances	Film and coating	Wire and cable	Consumer	Industrial/ machinery	Other	Total
2005	17	28	34	32	-	51	92	16	270
2006	20	31	36	37	-	56	97	16	293
2007	28	45	46	45	-	68	112	22	366
2008	30	43	42	47	-	54	102	20	338
2009	43	44	46	48	-	58	105	19	363
2010	49	46	47	50	-	64	111	23	390
2011	50	53	52	52	-	67	115	25	414
2012	53	59	57	53	-	72	120	26	439
2013	60	65	61	54	-	75	127	28	469
2014	65	71	66	54	-	80	133	29	497
2015	67	76	70	55	-	85	139	31	522
2020	85	107	97	57	-	108	169	35	658
			Average annual growth rate (percent)						
2015–20	5.1%	7.1%	6.8%	0.8%	—	4.9%	3.9%	2.9%	4.8%

Source: IHS Chemical estimates.

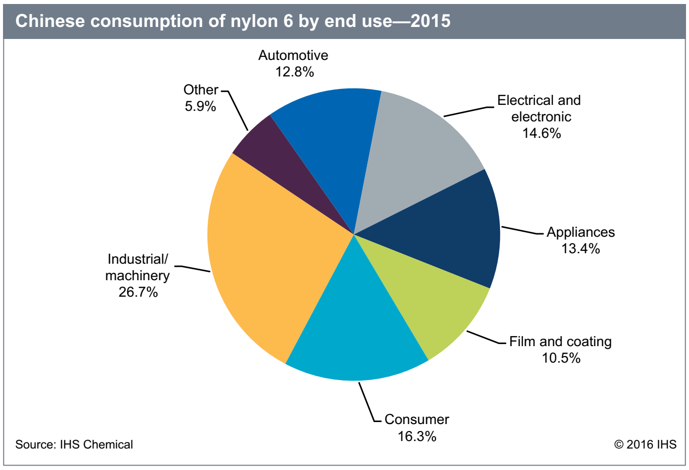
The following table presents Chinese consumption of nylon 66 resins:

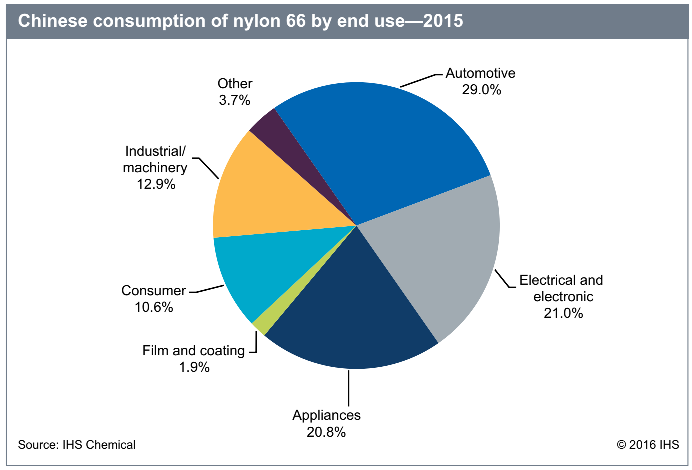
Chinese consumption of nylon 66
(thousands of metric tons)

	Automotive	Electrical and electronic	Appliances	Film and coating	Wire and cable	Consumer	Industrial/ machinery	Other	Total
2005	18	25	20	4	-	10	21	5	103
2006	31	38	39	5	-	22	36	9	180
2007	42	38	40	5	-	24	36	9	194
2008	44	39	42	5	-	25	36	10	201
2009	56	35	39	4	-	20	28	8	190
2010	64	38	42	5	-	23	30	9	211
2011	65	44	47	5	-	25	32	9	228
2012	69	49	50	6	-	27	33	10	243
2013	79	54	54	6	-	28	35	10	266
2014	85	59	58	6	-	30	37	11	285
2015	87	63	62	6	-	32	39	11	300
2020	112	89	87	6	-	40	47	14	395
			Average annual growth rate (percent)						
2015–20	5.1%	7.1%	6.8%	0.8%	—	4.9%	4.2%	4.7%	5.7%

Source: IHS Chemical estimates.

The following charts present the consumption of nylon resin by end use for nylon 6 and 66. Consumption of nylon resins is dominated by industrial/machinery parts production in China, with about 22% of total resin consumption in 2015.





In 2015, total consumption of nylon resins in China was about 822 thousand metric tons. China is the largest demand center for nylons and has one of the highest growth rates, expected at 5.1% per year in 2015–20.

Demand for nylon resins in China has increased significantly in recent years, as a result of growth of the automotive industry and electrical/electronic markets. In the electrical and electronics market, demand for nylon resins has continued to be driven not only by domestic manufacturers serving the household appliance and electronics needs of an increasingly prosperous Chinese population, but also by exports of electrical/electronic products and components from China.

Nylon resins are consumed in all end-use market segments except wire and cable. China's domestic market covers a broad range of end uses for nylon resins.

The largest consumption markets for nylon resins in China are industrial/machinery applications, followed by automotive applications, electrical/electronics, appliances, consumer goods, and film and coatings.

Industrial and machinery

Industrial and machinery applications utilized about 178 thousand metric tons of nylon resins and was the largest market in 2015, accounting for 22% of the total. The nylon type segmentation was about 139 thousand metric tons (78%) nylon 6 and 47 thousand metric tons (22%) nylon 66. These applications are expected to increase at an average annual rate of about 3.9% in 2015–20.

Automotive

Automotive applications consumed a total of 154 thousand metric tons of nylon resins in 2015. The nylon type segmentation was 67 thousand metric tons (43%) of nylon 6 and 87 thousand metric tons (57%) of nylon 66. Automotive applications accounted for about 19% of total nylon resin consumption in 2015 and will have a growth rate of about 5.1% from 2015 to 2020.

Electrical and electronic

Electrical and electronic applications consumed 76 thousand metric tons of nylon 6 and 63 thousand metric tons of nylon 66, for a total consumption of 139 thousand metric tons in 2015.

Electrical and electronic applications accounted for about 17% of total nylon resins consumption in 2015 and will be one of the fastest-growing markets in China at about 7.1% per year through 2020.

Appliances

A total of 132 thousand metric tons of nylon resins were consumed in appliances in 2015. About 70 thousand metric tons (53%) of nylon 6 and 62 thousand metric tons (47%) of nylon 66 were used.

Appliance applications accounted for about 16% of the total consumption of nylon resins in China and are expected to grow at an average annual rate of about 6.9% in 2015–20.

Consumer goods

Consumer goods consumed a total of 117 thousand metric tons of nylon resins in 2015, split between about 85 thousand metric tons of nylon 6 (73%) and 32 thousand metric tons of nylon 66 (27%). This market accounted for about 14% of total nylon resin consumption in 2015 and is expected to grow at about 3.7% per year in 2015–20.

Film and coating

Film and coatings consumed a total of 61 thousand metric tons of nylon resins in 2015. The nylon type segmentation was 55 thousand metric tons (90%) of nylon 6 and 6 thousand metric tons (10%) of nylon 66 in 2015. Film and coatings accounted for about 7% of the total nylon resin consumption in 2015 and are expected to have a growth rate of 0.8% per year in 2015–20.

Other

Other applications consumed about 42 thousand metric tons of nylon resins in 2015, split about 31 thousand metric tons (74%) of nylon 6 and 11 thousand metric tons (26%) of nylon 66. Other applications of nylon resins were about 5% of the total nylon resin consumption in 2015 and are growing at 3.4% per year from 2015 to 2020.

Trade

China's appetite for nylon resins is large and is growing steadily. Even with the largest production base in the world, China imported nearly 458 thousand metric tons of nylon 6 in 2015, compared to exports of only 25 thousand metric tons. However, the imports are expected to decline in the next five years as a result of the new capacity additions. By 2020, nylon 6 imports are expected to be about half the level in 2015.

China imported 259 thousand metric tons of nylon 66 and exported 46 thousand metric tons in 2015. Imports are expected to decline in the coming years due to the increase in domestic production. By 2020, the imports of nylon 66 are expected to fall by 24% from 2015 levels, as the country becomes more self-sufficient.

Japan

Japan produces both types of nylon resins but more nylon 6 than nylon 66 and accounts for less than 3% of the total world capacity. The country is a net importer of nylon resins. Recently, Japanese automotive and electrical/electronic parts manufacturing and molding has moved to China; hence, the production of nylon resins is increasing in China and has been declining in Japan.

Producing companies

The following table presents the producers of nylon 6 resins in Japan:

Japanese producers of nylon 6
(thousands of metric tons)

Company	Plant location	Average annual capacity 2013	2015	2020	Raw material and and process	Remarks
Mitsubishi Chemical	Kurosaki	20	0	0	N 6 continuous	Shut down mid-2013.
Toray	Nagoya	32	32	32	N 6 continuous	
	Okazaki	10	10	10	N 6 continuous	
Toyobo	Tsuruga	30	30	30	N 6 continuous	
Ube Industries	Ube City	60	60	60	N 6 autoclave	
Unitika	Uji	12	12	12	N 6 continuous	
Total		**164**	**144**	**144**		

Source: IHS Chemical estimates.

The total nylon 6 resin capacity in Japan was 144 thousand metric tons in 2015; in the last five years, Japan's nylon 6 capacity has declined by about 4.8% per year. In Japan, there is more nylon 6 than nylon 66 capacity.

There are four producers of nylon 6 in Japan, with the largest producer being Ube Industries with a capacity of 60 thousand metric tons. Toray is the second-largest producer in the country with a total capacity of 42 thousand metric tons distributed between two different locations.

- In mid-2013, Mitsubishi Chemical shut down its 40 thousand metric ton nylon 6 plant at Kurosaki, preferring to produce nylon 6 at other locations in Northeast Asia. Mitsubishi Engineering Plastics was established in 1994 by Mitsubishi Gas Chemical and Mitsubishi Chemical to strengthen the engineering plastics business of the two companies. Mitsubishi Chemical also has a subsidiary, Tai Young Nylon Co., Ltd., at Kaoshiung, Taiwan that continues to produce nylon 6.

- Ube is focused on caprolactam and nylon 6, and has two subsidiary companies outside Japan—Ube Chemicals Asia (formerly Ube Nylon Thailand Ltd.) in Thailand, established in 1995, and Ube Engineering Plastics. S.A. in Spain, established in 2004. Both companies produce nylon 6 resins.

- In late 2014, Ube closed the 115 thousand metric ton caprolactam facility in Sakai, Japan. The decision was a result of the global economic slowdown, declining domestic demand, and competition from Chinese counterparts. However, Ube expanded its nylon 6 capacity in Spain in 2015, driven by increasing demand for nylon 6 in Europe and North America.

The following table presents the producers of nylon 66 resins in Japan:

Japanese producers of nylon 66
(thousands of metric tons)

Company	Plant location	Average annual capacity 2013	2015	2020	Raw material and process	Remarks
Asahi Kasei Chem.	Nobeoka	36	36	36	N 66 continuous	Engineering plastic.
	Nobeoka	40	40	40	N 66 continuous	Engineering plastic.
Toray	Nagoya	22	22	22	N 66 continuous	
Total		**98**	**98**	**98**		

Source: IHS Chemical estimates.

The total nylon 66 resin capacity was 98 thousand metric tons in 2015. There are two producers of nylon 66 in Japan.

- Asahi Kasai Chemical has a nameplate capacity of 76 thousand metric tons in 2015 and is the largest producer in the country. The company specializes in nylon 66 production, with an integrated captive source of raw materials.

- Toray has three nylon plants in Japan with a total capacity of 64 thousand metric tons in 2015. Toray is the only company to produce both types of nylons in Japan, but the nylon 6 capacity (42 thousand metric tons) is much larger than that for nylon 66 (22 thousand metric tons).

Salient statistics

Nylon 6

The following table presents Japanese supply/demand for nylon 6:

Japanese supply/demand for nylon 6
(thousands of metric tons)

	Annual capacity	Operating rate (percent)	Production	Imports	Exports	Actual consumption
1990	145	38	55	30	1	67
1995	288	111	321	8	54	151
2000	275	122	335	11	56	201
2001	275	111	306	10	56	147
2002	275	104	286	17	56	147
2003	234	107	251	20	46	135
2004	234	104	243	20	46	136
2005	234	101	237	23	51	135
2006	234	97	226	25	40	138
2007	234	103	242	16	40	147
2008	228	98	222	18	38	140
2009	228	75	171	8	34	112
2010	184	97	179	25	35	129
2011	184	94	173	26	37	122
2012	184	91	168	27	30	127
2013	164	94	154	28	20	125
2014	144	97	140	31	10	126
2015	144	82	118	44	7	123

Source: IHS Chemical estimates.

Japan produced about 118 thousand metric tons of nylon 6 in 2015 at an operating rate of 82%.

No new capacity expected to come onstream in the next five years and the operating rate is expected to remain at around 80–82% through 2020. Due to sluggish growth in demand, the production of nylon 6 in Japan not expected to grow and may actually decline.

Nylon 66

The following table presents Japanese supply/demand for nylon 66:

Japanese supply/demand for nylon 66
(thousands of metric tons)

	Annual capacity	Operating rate (percent)	Production	Imports	Exports	Actual consumption
1990	-	-	-	-	1	-
1995	-	-	117	27	21	16
2000	46	255	118	35	37	13
2001	59	158	93	32	27	32
2002	99	76	75	36	38	32
2003	99	94	93	39	50	40
2004	99	100	99	53	54	45
2005	99	108	107	48	40	58
2006	76	147	112	61	57	59
2007	76	152	115	62	60	63
2008	76	135	103	68	56	60
2009	98	88	87	42	36	48
2010	98	103	101	70	53	58
2011	98	100	98	64	49	53
2012	98	100	98	71	53	58
2013	98	99	97	77	60	57
2014	98	99	97	90	70	57
2015	98	98	96	89	71	55

Source: IHS Chemical estimates.

The nylon 66 plants have been operating at high rates due to the inherent domestic demand for the product, although in the past five years the production of nylon 66 declined by about 0.9% per year. In 2015, Japan produced 96 thousand metric tons of nylon 66. After trade, the region consumed a total of 115 thousand metric tons of nylon 66 of which 48%, or 55 thousand metric tons were consumed in engineering applications.

Consumption

Japanese demand for nylon resins grew steadily through the 1980s with growth rates averaging over 10% per year. The slowdown in the early 1990s is attributed to the general economic downturn. After 2000, the Japanese economy declined until 2002, then recovered again and continued to rebound through 2006 before the world economic recession began in 2008. Nylon markets are still recovering, but are not expected to reach former levels during the forecast period.

In Japan, nylon-consuming industries, especially automotive and electrical/electronics, were impacted by the recession in 2008 and 2009. Nylon resin demand decreased about 5% in 2008 and a total of 24% in 2009 from 2007 values. But the demand volumes recovered significantly in 2010, although the markets have since plateaued through 2015.

The following table presents Japan consumption of nylon 6 resins:

Japanese consumption of nylon 6
(thousands of metric tons)

	Automotive	Electrical and electronic	Appliances	Film and coating	Wire and cable	Consumer	Industrial/ machinery	Other	Total
2005	30	23	8	45	-	7	10	12	135
2006	32	23	8	45	-	8	10	12	138
2007	38	25	8	46	-	8	10	12	147
2008	35	23	8	47	-	7	9	11	140
2009	25	19	6	44	-	4	6	8	112
2010	34	21	7	47	-	6	6	8	129
2011	30	19	7	47	-	6	6	7	122
2012	36	18	7	47	-	6	6	7	127
2013	35	17	7	47	-	6	6	7	125
2014	35	17	8	47	-	6	6	7	126
2015	33	16	8	47	-	6	6	7	123
2020	33	18	8	46	-	6	7	8	126
				Average annual growth rate (percent)					
2015–20	-0.1%	2.0%	1.6%	-0.1%	—	1.1%	1.1%	1.1%	0.5%

Source: IHS Chemical estimates.

The following table presents Japan consumption of nylon 66 resins:

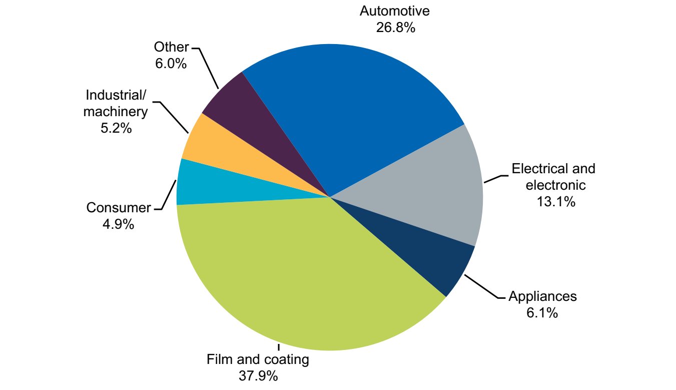
Japanese consumption of nylon 66
(thousands of metric tons)

	Automotive	Electrical and electronic	Appliances	Film and coating	Wire and cable	Consumer	Industrial/ machinery	Other	Total
2005	36	11	2	2	-	-	5	2	58
2006	37	11	2	2	-	-	5	2	59
2007	39	12	3	2	-	-	5	2	63
2008	38	11	2	2	-	-	5	2	60
2009	28	10	2	2	-	-	4	2	48
2010	35	13	2	2	-	-	4	2	58
2011	31	11	2	2	-	-	4	2	53
2012	37	11	2	2	-	-	4	2	58
2013	36	11	2	2	-	-	4	2	57
2014	36	10	2	2	-	-	4	2	57
2015	34	10	2	2	-	-	4	2	55
2020	34	11	2	2	-	-	4	2	56
				Average annual growth rate (percent)					
2015–20	-0.1%	2.0%	1.6%	-0.1%	—	—	1.1%	1.1%	0.5%

Source: IHS Chemical estimates.

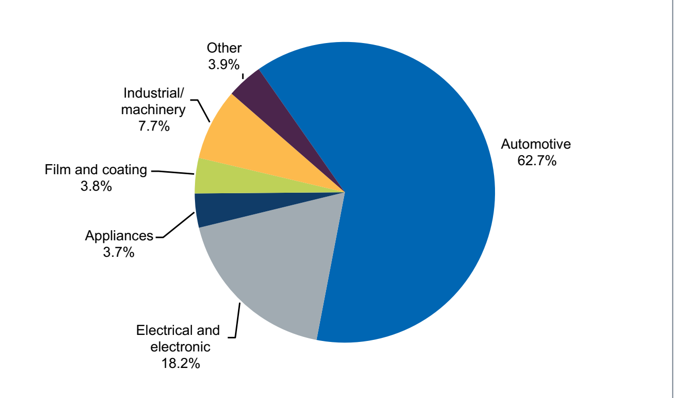
The following charts show the consumption of nylon resins by end use for nylon 6 and nylon 66:

Japanese consumption of nylon 6 by end use—2015



Source: IHS Chemical © 2016 IHS

Japanese consumption of nylon 66 by end use—2015



Source: IHS Chemical © 2016 IHS

In 2015, the total consumption of nylons was about 269 thousand metric tons, nylon resins accounting for 178 thousand metric tons. Automotive uses consumed about 67 thousand metric tons (38%), followed by film and coatings at about 49 thousand metric tons (27%) and electrical and electronic applications at about 26 thousand metric tons (15%) of total nylon resin consumption in 2015.

Automotive

In 2015, the Japan produced about 8.9 million vehicles or about 9.9% of the total vehicle production in the world. The total nylon consumed in this application was about 67 thousand metric tons in 2015, with nylon 66 accounting for 51% of the total. In the next five years, Japan's vehicle production is forecast to decline at about 0.1% per year, as production of Japanese vehicle is shifted to other locations. As a result, demand for nylon resin in automotive application is expected to decline at around the same rate, and remain at about 67 thousand metric tons through 2020.

In the automotive market, the new development of external parts that can withstand paint-oven temperatures, as well as under-the-hood parts such as vapor canisters and cylinder head covers that can withstand heat emissions from engines, have played a key role in the rapid growth of nylon 66.

From 2000 to 2008, consumption of nylon 66 for this market steadily increased because nylon 66 replaced some metal parts by virtue of being lighter, less expensive, and easier to assemble. The market recovered after the economic downturn; however, in recent years this sector has plateaued in Japan.

On the other hand, wire harness connectors once used nylon 66 but have been replaced by glass-reinforced PBT. However, recently, some of these have been replaced by semi-aromatic nylon resins.

In automotive applications, air intake manifolds are one of the biggest end-use items. Conventional material for this part had been aluminum, which was replaced by plastics, as it was done in Europe, first with nylon 66 and increasingly with nylon 6. In Europe, the lost core method was adopted, whereas, in Japan the vibration welding method and DSI (die slide injection-molding method) are used by many Japanese car manufactures. Now, most air intake manifolds are vibration-welded nylon 6.

Nylon 6 is more desirable than nylon 66 for vibration welding because nylon 6 is easier to weld and has a lower cost than nylon 66. Parts such as radiator fans and brake fluid reservoirs are made of glass fiber–reinforced nylon 6 resins. The development of higher-performance compounds that exhibit heat resistance, superior appearance, and high rigidity has contributed to the growth of nylon in this market. They are used in applications such as cylinder head covers and wheel covers.

The historical growth of nylon 66 is attributed to the resin's superior heat resistance, higher melt temperature, and higher flex modulus at high temperatures; these are desirable properties for automotive applications.

Film and coating

Film and coating, primarily for food packaging, was one of the largest markets for nylons in 2015. Film and coating applications are dominated by nylon 6 and consumed about 49 thousand metric tons in 2015, of which about 96% was nylon 6. This is one of the most active Japanese markets.

Nylon 6 is specifically employed for multilayer food packaging. In this application, tear strength, thermal resistance, low gas permeability, low-temperature tear resistance, and ease of processing are key factors responsible for its growth. The majority of the film is biaxially oriented nylon that is usually laminated to other films to produce the multilayer packaging material. The other big applications for films are coextrusion with other resins such as polyethylene or EVOH (ethylene–vinyl alcohol). Improvements in gloss, clarity, film manufacturing processes, and lower gas permeability at high humidity are expected to contribute to the growth in demand for nylon 6 film.

Electrical and electronic

In electrical and electronic applications, both nylon 6 and nylon 66 are used. Nylon 66 has been used primarily for connectors, coil bobbins, and small motor parts, and when high heat resistance or high modulus is required. Typical applications include connectors, wire and cable ties, and miscellaneous electrical parts. Despite the higher price of nylon 66, it is used for these applications in about the same amounts as nylon 6 because of its performance requirements of the specific applications. Recently, the electrical and electronics industries have been moving to other Asian countries, mainly China. Primarily nylon compounds are used in these countries, not neat resins. Therefore, many Japanese nylon producers have established compounding companies in these countries, and are producing their own compounds.

Other

Miscellaneous applications for nylon 66 include parts for office desks and chairs where metal was formerly used, such as for casters and wheels.

Currently, most engineering nylon 66 is consumed in injection-molding applications. Gas-injection and blow-molding applications have also been creating new markets.

Monofilament applications are primarily fishing nets and industrial uses. No growth or even decreasing growth in the near future is predicted for fishing nets because of the maturity of the fishing industry in Japan.

In the next five years, Japan consumption of nylon resin is expected to grow at about 0.5% per year, reaching 182 thousand metric tons by 2020.

- Consumption for automotive applications is expected to decline in the next five years. The primary reason for this decline is that more automobile manufacturing is moving offshore to China and other Asian locations.

- Film and coating consumption levels are expected to decline slightly during the forecast period.

- Electrical and electronic market consumption of nylons is expected to grow at a moderate rate of about 2.0% per year and reach 29 thousand metric tons by 2020.

Trade

In the last five years, Japan has shifted toward a net import position for nylon 6, because of the availability of low cost materials from China. In 2015, Japan imported 44 thousand metric tons of nylon 6 and exported only 7 thousand metric tons.

Japan, however, has always been a net importer of nylon 66 and will continue to be so. In 2015, nylon 66 imports were 89 thousand metric tons and exports were 71 thousand metric tons. Imports are predominantly from the United States, Western Europe, and Singapore.

South Korea

South Korea produces nylon 6 and nylon 66, with the former product on a much larger scale. The country was a net exporter of nylon 6, but shifted to a net-import position since 2014; South Korea remains a small net importer of nylon 66.

Producing companies

The following table presents the producers of nylon 6 resins in South Korea:

South Korean producers of nylon 6
(thousands of metric tons)

Company	Plant location	Average annual capacity 2013	2015	2020	Raw material and and process	Remarks
Hyosung Corp.	Anyang	16	0	0	N 6 continuous	
	Ulsan	110	110	110	N 6 continuous	
Kolon	Gumi	100	24	24	N 6 continuous	Chemtex technology.
KP Chemtec	Ulsan	18	18	18	N 6 continuous	
Taekwang Ind.	Ulsan	54	54	54	N 6 continuous	
Total		**298**	**206**	**206**		

Source: IHS Chemical estimates. © 2016 IHS

There are four producers of nylon 6 in the South Korea with a total capacity of 206 thousand metric tons. The largest producer, Hyosung Corp., shut down a small 16 thousand metric ton plant at Anyang in 2013, leaving it with a capacity of 110 thousand metric tons, accounting for 53% of the total capacity.

The second-largest producer of nylon 6 in the region is Taekwang Industrial with a total capacity of 54 thousand metric tons in 2015. In 2013, Kolon reduced its nylon 6 capacity to 24 thousand metric tons. No capacity changes are expected in the next five years.

The following table presents the producers of nylon 66 resins in South Korea:

South Korean producers of nylon 66
(thousands of metric tons)

Company	Plant location	Average annual capacity 2013	2015	2020	Raw material and process
Rhodia	Onsan	55	55	55	N 66 continuous
Total		**55**	**55**	**55**	

Source: IHS Chemical estimates. © 2016 IHS

The total nylon resin capacity for nylon 66 is 55 thousand metric tons in 2015. Rhodia (owned by Solvay) is the only producer; the company began production of nylon 66 in 2008.

Salient statistics

Nylon 6

The following table presents South Korean supply/demand for nylon 6:

South Korean supply/demand for nylon 6 (thousands of metric tons)						
	Annual capacity	Operating rate (percent)	Production	Imports	Exports	Actual consumption
1990	175	141	246	-	-	31
1995	306	103	315	8	5	21
2000	355	98	349	36	19	57
2001	355	78	276	33	19	37
2002	298	100	297	32	21	37
2003	298	96	287	24	15	42
2004	298	91	272	36	19	45
2005	298	89	267	31	48	54
2006	298	89	266	33	52	56
2007	298	82	246	30	47	65
2008	298	75	223	27	58	57
2009	298	75	223	22	56	59
2010	298	96	286	19	78	62
2011	298	94	280	32	77	64
2012	298	86	256	42	73	64
2013	298	77	229	45	73	64
2014	206	84	173	73	50	65
2015	206	83	170	74	50	65

Source: IHS Chemical estimates.

South Korea produced 170 thousand metric tons of nylon 6 at an operating rate of 83% in 2015. There is no capacity additions expected in South Korea during the forecast period. The capacity utilization rate is expected to fall to about 76% as production declines at about 1.7% per year over the next five years.

Nylon 66

The following table presents South Korean supply/demand for nylon 66:

South Korean supply/demand for nylon 66 (thousands of metric tons)						
	Annual capacity	Operating rate (percent)	Production	Imports	Exports	Actual consumption
1990	-	-	-	-	-	-
1995	-	-	-	8	-	2
2000	-	-	-	12	-	6
2001	-	-	-	9	-	9
2002	-	-	-	24	-	25
2003	-	-	-	40	9	28
2004	-	-	-	52	13	30
2005	-	-	-	62	15	36
2006	-	-	-	68	17	40
2007	-	-	-	70	16	42
2008	36	58	21	58	32	38
2009	36	80	29	49	42	26
2010	48	73	35	76	62	39
2011	48	73	35	79	62	42
2012	55	92	50	74	64	41
2013	55	98	54	80	73	41
2014	55	98	54	87	80	41
2015	55	98	54	78	70	42

Source: IHS Chemical estimates.

Rhodia produced 54 thousand metric tons of nylon 66 at an operating rate of 98% in 2015. No additional capacity is expected in the next five years, and so operating rates will remain high (about 98%) as long as production continues at the current level. In comparison, South Korea imports a large quantity of nylon 66, making its total supply about 132 thousand metric tons in 2015, which after exports left about 62 thousand metric tons to be consumed domestically. Engineering applications consumed about 42 thousand metric tons or nearly 68% of the total.

Consumption

South Korea consumed about 259 thousand metric tons of nylon 6 and 66 in 2015. Nylon resin applications consumed about 41% of the total; and the remainder is consumed in fiber applications. In the last five years, consumption of nylon in the region has grown at about 6.7% per year; in the next five years, however, total consumption is expected to decline due to reduced demand for nylon in fiber applications.

The following table presents South Korean consumption of nylon 6 resins:

South Korean consumption of nylon 6
(thousands of metric tons)

	Automotive	Electrical and electronic	Appliances	Film and coating	Wire and cable	Consumer	Industrial/ machinery	Other	Total
2005	15	2	3	24	-	3	4	3	54
2006	16	3	3	24	-	2	5	3	56
2007	19	4	3	25	-	3	6	5	65
2008	16	2	2	26	-	3	5	3	57
2009	17	4	2	26	-	3	4	3	59
2010	19	4	2	26	-	4	5	2	62
2011	21	4	2	26	-	4	5	3	64
2012	20	4	2	26	-	4	5	3	64
2013	20	4	2	26	-	4	5	3	64
2014	20	4	2	26	-	4	5	3	65
2015	20	4	2	26	-	4	6	3	65
2020	18	5	3	26	-	5	6	3	67
Average annual growth rate (percent)									
2015–20	-2.0%	3.9%	3.1%	0.4%	—	2.7%	2.7%	2.5%	0.4%

Source: IHS Chemical estimates.

The following table presents South Korean consumption of nylon 66 resins:

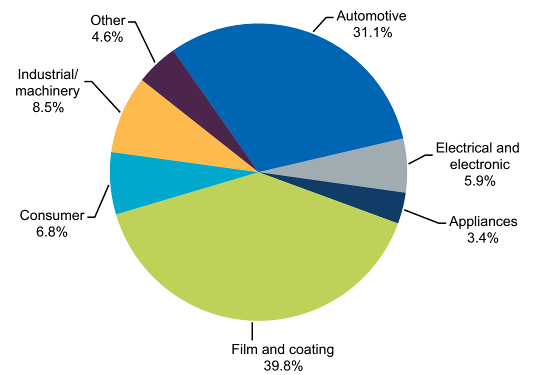
South Korean consumption of nylon 66
(thousands of metric tons)

	Automotive	Electrical and electronic	Appliances	Film and coating	Wire and cable	Consumer	Industrial/ machinery	Other	Total
2005	22	2	2	2	-	2	4	2	36
2006	24	2	3	2	-	3	4	2	40
2007	25	3	3	2	-	3	4	2	42
2008	24	2	2	2	-	2	4	2	38
2009	18	1	1	2	-	1	2	1	26
2010	24	3	2	2	-	2	4	2	39
2011	27	3	2	2	-	2	4	2	42
2012	26	3	2	2	-	2	4	2	41
2013	26	3	2	2	-	2	4	2	41
2014	26	3	2	2	-	2	4	2	41
2015	26	3	2	2	-	2	4	2	42
2020	23	3	3	2	-	3	5	2	41
				Average annual growth rate (percent)					
2015–20	-2.0%	3.9%	3.1%	0.6%	—	2.7%	2.7%	2.5%	-0.1%

Source: IHS Chemical estimates.

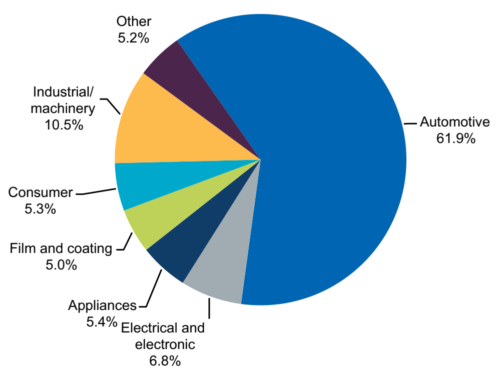
The following charts present consumption of nylon resins by end use for nylon 6 and nylon 66:

South Korean consumption of nylon 6 by end use—2015



Source: IHS Chemical

South Korean consumption of nylon 66 by end use—2015



Source: IHS Chemical

In 2015, total consumption of nylon resins was about 107 thousand metric tons, and is expected to relatively stable, increasing at only 0.2% per year through the forecast period.

Automotive applications drive the consumption of nylon resins in South Korea. These applications consumed about 46 thousand metric tons of nylon resins, or about 43% of total consumption in 2015. About 20 thousand metric tons (43%) nylon 6 and 26 thousand metric tons (57%) nylon 66 were used in automotive applications. In the next five years, this application is expected to decline at an average annual rate of about 2%.

Film and coatings accounted for 26% of the nylon market in 2015, consuming about 28 thousand metric tons of nylon resins. Around 26 thousand metric tons (93%) nylon 6 and 2 thousand metric tons (7%) nylon 66 were consumed in these applications. The consumption of nylon resins in these applications is growing at an average annual rate of 0.4% in the next five years.

Other applications of nylon resins are much smaller in volume, consuming 4–10 thousand metric tons each in 2015. Total consumption of nylon 6 and nylon 66 is expected to grow at an average rate of only 0.2% per year in 2015–20.

Due to the difference in physical properties, nylon 6 and 66 cater to unique, different applications. Nylon 66 is preferred in end uses that require higher heat stability as well as higher strength properties. However, nylon 6 has better appearance and aesthetics.

Trade

In the last five years, South Korea has switched from a net exporter to a net importer of nylon 6; the country has always been a net importer of nylon 66.

In 2015, imports of nylon 6 were 74 thousand metric tons and exports were 50 thousand metric tons. For nylon 66, imports were around 78 thousand metric tons and exports were 70 thousand metric tons.

South Korea has an advantage due to its geographic proximity to other Asian countries, where there is higher demand for nylon 6 resins. About 57% of South Korean nylon exports were sent to China in 2015, while most imports came from the United States (47%) and Western Europe (32%). With sluggish growth in domestic demand, the country is more likely to continue to export nylon 6 resins.

Taiwan

Taiwan is one of the largest global producers of nylon 6 and was the second-largest exporter of nylon 6 resins in 2015. In contrast, the country produces a meager (13 thousand metric tons) volume of nylon 66 and so the domestic demand is addressed by imports.

Producing companies

The following table presents the producers of nylon 6 resins in Taiwan:

Taiwanese producers of nylon 6
(thousands of metric tons)

Company	Plant location	Average annual capacity 2013	2015	2020	Raw material and and process	Remarks
Chain Yarn	Taichung	95	95	95	N 6 continuous	
CPDC	Toufen	40	40	40	N 6 continuous	
FCFC	Changhwa	70	70	70	N 6 continuous	
	Chiayi	133	133	133	N 6 Continuous	
Li Peng	Changhwa	390	390	390	N 6 continuous	
	Changhwa	0	30	180	N 6 continuous	New.
Tai-Young Nylon	Kaohsiung	12	12	12	N 6 continuous	DSM.
Zig Sheng	Kaohsiung	216	216	216	N 6 continuous	
Total		**956**	**986**	**1,136**		

Source: IHS Chemical estimates. © 2016 IHS

The total nylon 6 resin capacity in Taiwan was about 986 thousand metric tons in 2015. There are six producers of nylon 6 in Taiwan, with Li Peng being the largest producer with a total capacity of 420 thousand metric tons in 2015. The second-largest producer in Taiwan is Zig Sheng with a capacity of 216 thousand metric tons in 2015; Zig Sheng acquired Hualon Chemical's 60 thousand metric ton nylon 6 plant in 2011.

The following table presents the producers of nylon 66 resins in Taiwan:

Taiwanese producers of nylon 66 (thousands of metric tons)					
		Average annual capacity			
Company	Plant location	2013	2015	2020	Raw material and process
Grand Pacific	Ta Sheh	10	13	15	N 66 continuous
	Ta Sheh	0	0	15	N 66 continuous
Total		**10**	**13**	**30**	

Source: IHS Chemical estimates. © 2016 IHS

The total nylon 66 resin capacity reached 13 thousand metric tons in 2015. Grand Pacific is the only producer of nylon 66 in Taiwan; the plant was started up in mid-2012 and uses imported HMDA as a feedstock. Grand Pacific is expected to add further capacity in 2016 and 2017, when their total capacity will be about 30 thousand metric tons.

In order to produce nylon 66, Taiwan has to have access to adiponitrile, HMDA, or nylon salt. In addition, China and Taiwan are both structurally dependent on imported caprolactam and regional shortages have been a major factor in global price escalation in recent years; however, this situation is changing. Capacity additions for these feedstocks are expected to come onstream in China, Taiwan, and the Middle East. Demand is growing in Asia and it is expected to gradually absorb the additional capacity.

Salient statistics

Nylon 6

The following table presents Taiwan's supply/demand for nylon 6:

Taiwanese supply/demand for nylon 6 (thousands of metric tons)						
	Annual capacity	Operating rate (percent)	Production	Imports	Exports	Actual consumption
1990	-	-	206	-	-	4
1995	155	175	272	41	15	40
2000	650	65	424	107	47	14
2001	618	71	440	82	48	20
2002	593	75	442	103	81	1
2003	579	84	489	70	77	20
2004	601	86	519	73	92	24
2005	652	89	581	45	142	15
2006	798	86	686	27	236	16
2007	888	79	703	18	307	16
2008	872	68	592	19	307	14
2009	872	74	647	19	368	11
2010	926	74	681	25	332	13
2011	980	64	627	28	322	13
2012	954	69	659	12	363	13
2013	956	73	694	12	398	14
2014	956	69	660	8	369	14
2015	986	63	621	9	329	14

Source: IHS Chemical estimates. © 2016 IHS

Taiwan produced 621 thousand metric tons of nylon 6 in 2015 at an operating rate of 63%. No capacity additions are expected in the future in Taiwan; production and capacity utilization rates are expected to decline in the next five years. Domestic consumption of nylon 6 resins in Taiwan is very small (14 thousand metric tons) in comparison to export volumes (329 thousand metric tons).

Nylon 66

The following table presents Taiwan's supply/demand for nylon 66:

Taiwanese supply/demand for nylon 66
(thousands of metric tons)

	Annual capacity	Operating rate (percent)	Production	Imports	Exports	Actual consumption
1990	-	-	-	-	-	-
1995	-	-	-	16	-	-
2000	-	-	-	16	-	21
2001	-	-	-	16	-	20
2002	-	-	-	20	-	1
2003	-	-	-	51	13	14
2004	-	-	-	63	15	16
2005	-	-	-	62	9	10
2006	-	-	-	66	8	19
2007	-	-	-	60	9	19
2008	-	-	-	64	7	17
2009	-	-	-	47	6	15
2010	-	-	-	61	13	20
2011	-	-	-	76	16	21
2012	5	100	5	69	13	21
2013	10	103	10	69	17	21
2014	10	120	12	69	19	22
2015	13	100	13	72	21	23

Source: IHS Chemical estimates.

There is only one plant that produces nylon 66 in Taiwan. The Grand Pacific plant at Ta Sheh was started in mid-2012; the capacity has expanded to about 13–15 thousand metric tons in 2015. In 2015, the unit produced about 13 thousand metric tons of nylon 66, or about 56% of the nylon 66 consumed in the region.

Taiwan is mainly import-dependent to meet its domestic needs for nylon 66. Capacity at Ta Sheh is expected to double in the next few years and so imports are expected to stabilize at the current level.

In 2015, Taiwan consumed a total of 64 thousand metric tons of nylon 66. Nylon resin applications consumed only 23 thousand metric tons, or 36% of the total nylon 66 consumption.

Consumption

The following table presents Taiwan's consumption of nylon 6 resins:

Taiwanese consumption of nylon 6 (thousands of metric tons)									
	Automotive	Electrical and electronic	Appliances	Film and coating	Wire and cable	Consumer	Industrial/ machinery	Other	Total
2005	2	3	1	4	-	2	2	1	15
2006	2	3	2	5	-	1	1	2	16
2007	2	3	2	5	-	1	1	2	16
2008	2	2	2	4	-	1	1	2	14
2009	1	2	1	4	-	1	1	1	11
2010	1	2	2	4	-	1	1	2	13
2011	1	2	2	4	-	1	1	2	13
2012	1	2	2	4	-	1	1	2	13
2013	1	2	2	4	-	1	1	2	14
2014	1	2	2	4	-	1	1	2	14
2015	1	2	2	4	-	1	1	2	14
2020	1	3	3	4	-	1	1	2	16
Average annual growth rate (percent)									
2015–20	-1.2%	4.6%	3.7%	0.6%	—	2.1%	1.4%	1.9%	2.0%

Source: IHS Chemical estimates.

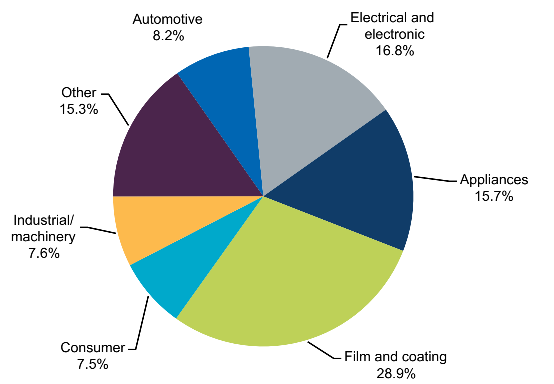
The following table presents Taiwan's consumption of nylon 66 resins:

Taiwanese consumption of nylon 66 (thousands of metric tons)									
	Automotive	Electrical and electronic	Appliances	Film and coating	Wire and cable	Consumer	Industrial/ machinery	Other	Total
2005	2	2	2	-	-	1	2	1	10
2006	2	4	2	-	-	4	5	2	19
2007	2	4	2	-	-	4	5	2	19
2008	2	4	1	-	-	3	5	2	17
2009	1	3	2	-	-	3	5	1	15
2010	3	4	3	-	-	4	5	1	20
2011	3	4	3	-	-	4	5	1	21
2012	3	4	3	-	-	4	5	1	21
2013	3	4	3	-	-	4	5	1	21
2014	4	5	3	-	-	4	5	1	22
2015	4	5	3	-	-	4	5	1	23
2020	3	6	4	-	-	5	6	1	25
Average annual growth rate (percent)									
2015–20	-1.2%	4.6%	3.7%	—	—	2.1%	1.4%	2.1%	2.3%

Source: IHS Chemical estimates.

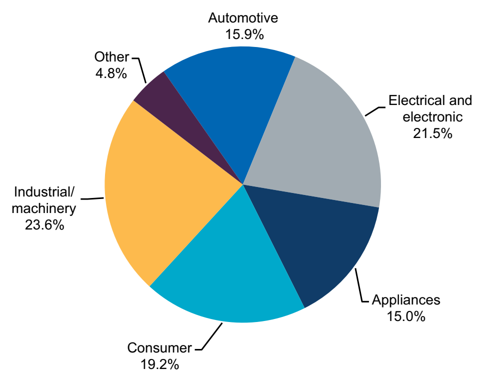
The following charts show the consumption of nylon resin by end use for nylon 6 and nylon 66. Taiwan is one of the few countries, discussed in this report, where the consumption of nylon 6 and nylon 66 is not dominated by automotive applications.

Taiwanese consumption of nylon 6 by end use—2015



Source: IHS Chemical © 2016 IHS

Taiwanese consumption of nylon 66 by end use—2015



Source: IHS Chemical © 2016 IHS

Taiwan's consumption of nylon 6 is very small compared to its capacity; the Taiwanese market is geared toward exports. In 2015, total consumption of nylon resins was only 37 thousand metric tons and is forecast to increase to about 41 thousand metric tons by 2020.

All the applications consume small volumes of the product, ranging from 1–7 thousand metric tons. Nylon 66 accounted for about 62% of the consumption, with the overall consumption of nylons in Taiwan expected to grow at 2.1% per year in 2015–20.

Trade

Taiwan was a large net exporter of nylon 6 and a net importer of nylon 66 in 2015.

In 2015, imports of nylon 6 were around 9 thousand metric tons and exports were at 329 thousand metric tons. China is the main destination for Taiwan's nylon 6 exports; in 2015 China accounted for about 67% of the total. With a huge capacity and small domestic demand, Taiwan will continue to be a net exporter of nylon 6.

The country imported 72 thousand metric tons and re-exported (even though Taiwan has a small nylon 66 presence) 21 thousand metric tons of nylon 66. Most of the nylon 66 comes from the United States (55%). Taiwan has a location advantage when it comes to exporting to other Asian countries.

Southeast Asia

Southeast Asia produces nylon 6 on a much larger scale than nylon 66. The region is a net importer of nylon 66, but is relatively balanced in nylon 6 trade.

Producing companies

The following table presents the producers of nylon 6 resins in Southeast Asia:

Southeast Asian producers of nylon 6
(thousands of metric tons)

Company	Plant location	Average annual capacity 2013	2015	2020	Raw material and and process	Remarks
Indonesia						
Filamendo Sakti	Tangerang	45	45	45	N 6 continuous	
Indonesia Toray	Pasar-Baru	20	20	20	N 6 continuous	
Malaysia						
Recron (Malaysia)	Nilai	36	36	36	N 6 continuous	From Hualon.
Thailand						
Asia Fiber	Samut Prakan	22	22	22	N 6 continuous	
Thai Taffeta	Bangkok	13	13	13	N 6 continuous	
Ube Chemicals (Asia)	Bangkhen	81	81	81	N 6 continuous	From Ube Nylon.
Vietnam						
Formosa Industries	Dong Nai	50	50	50	N 6 continuous	
Total		**267**	**267**	**267**		

Source: IHS Chemical estimates.

The total nylon 6 resin capacity in Southeast Asia was about 267 thousand metric tons in 2015.

- Thailand is the largest producer of nylon 6 in the region with a capacity of 116 thousand metric tons. Other producing countries are Indonesia (65 thousand metric tons), Vietnam (50 thousand metric tons), and Malaysia (36 thousand metric tons).
- Thailand has the highest capacity share in the region at 43% of the total, followed by Indonesia with 24%, Vietnam with 19%, and Malaysia with 13%.
- Formosa Industries started a nylon 6 polymer facility in Vietnam in 2011 to support fiber and plastic demand in that country.
- Thailand's largest producer is Ube Chemicals, with a total capacity of 81 thousand metric tons in 2015.
- The next-largest plants in the region are the Formosa Industries plant in Vietnam (50 thousand metric tons) and Filamendo Sakti in Indonesia (45 thousand metric tons).

The following table presents the producers of nylon 66 resins in Southeast Asia:

Southeast Asian producers of nylon 66
(thousands of metric tons)

Company	Plant location	Average annual capacity 2013	2015	2020	Raw material and process
Singapore					
DuPont Singapore	Singapore	60	60	60	N 66 continuous
Total		**60**	**60**	**60**	

Source: IHS Chemical estimates.

The total nylon 66 resin capacity was 60 thousand metric tons in 2015. DuPont Singapore is the only producer of nylon 66 in Southeast Asia. There are no capacity additions anticipated in the next five years.

Salient statistics

Nylon 6

The following table presents Southeast Asian supply/demand for nylon 6:

Southeast Asian supply/demand for nylon 6
(thousands of metric tons)

	Annual capacity	Operating rate (percent)	Production	Imports	Exports	Actual consumption
1990	77	50	39	-	-	-
1995	170	73	124	8	-	9
2000	191	70	134	57	37	41
2001	191	84	160	41	33	45
2002	181	87	158	70	39	46
2003	191	90	171	66	48	47
2004	181	87	157	107	78	47
2005	174	82	143	99	64	42
2006	156	88	136	100	63	51
2007	161	73	117	109	60	55
2008	167	57	95	131	57	62
2009	167	79	132	91	49	57
2010	180	75	135	116	69	63
2011	229	72	164	130	101	65
2012	267	72	193	127	131	70
2013	267	73	195	138	130	72
2014	267	72	191	146	142	74
2015	267	70	187	136	129	75

Source: IHS Chemical estimates. © 2016 IHS

In 2015, Southeast Asia produced 187 thousand metric tons of nylon 6 at an operating rate of 70%. There are no capacity additions expected in the next five years in Southeast Asia. After trade, the region consumes about 194 thousand metric tons of nylon 6, with nylon resin applications accounting for 75 thousand metric tons or about 39% of the total.

Nylon 66

The following table presents Southeast Asian supply/demand for nylon 66:

Southeast Asian supply/demand for nylon 66
(thousands of metric tons)

	Annual capacity	Operating rate (percent)	Production	Imports	Exports	Actual consumption
1990	-	-	3	-	-	-
1995	-	-	10	43	-	18
2000	60	56	34	63	40	24
2001	60	56	34	52	39	14
2002	60	63	38	45	44	15
2003	60	63	38	57	52	17
2004	60	65	39	42	31	20
2005	60	67	40	47	37	23
2006	60	80	48	54	48	27
2007	60	88	53	59	47	34
2008	60	88	53	62	48	37
2009	60	52	31	61	30	30
2010	60	72	43	88	60	36
2011	60	81	48	89	57	36
2012	60	75	45	98	56	40
2013	60	92	55	108	70	41
2014	60	81	49	121	70	42
2015	60	86	52	126	65	42

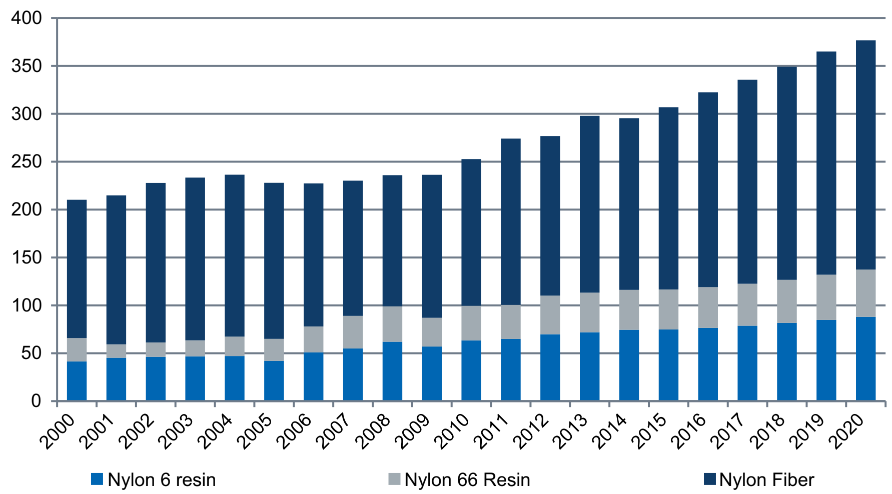
Source: IHS Chemical estimates.

In 2015, Southeast Asia produced 52 thousand metric tons of nylon 66 at an operating rate of 86%. Southeast Asia imports about three times its production, and after trade consumes about 112 thousand metric tons. Nylon resin applications account for 42 thousand metric tons, or about 37% of the total consumption.

Consumption

The following chart shows that about 307 thousand metric tons of nylon 6 and 66 were consumed in Southeast Asia in 2015. Nylon resin applications consumed about 37% of the total; and the remainder is consumed in fiber applications. In the last five years, total consumption of nylon in the region has been growing at about 4% per year, driven by fiber applications (4.4% per year). Nylon resin consumption has been growing at a slower rate of about 3.3% per year.

Southeast Asian consumption of nylon by application



Notes: Data are in thousands of metric tons
Source: IHS Chemical

The following table presents Southeast Asian consumption for nylon 6 resins:

Southeast Asian consumption of nylon 6
(thousands of metric tons)

	Automotive	Electrical and electronic	Appliances	Film and coating	Wire and cable	Consumer	Industrial/ machinery	Other	Total
2005	4	3	6	10	-	4	8	7	42
2006	7	3	8	16	-	4	8	5	51
2007	7	4	8	19	-	5	6	6	55
2008	7	4	8	20	-	7	8	8	62
2009	8	4	5	20	-	7	8	6	57
2010	9	5	7	21	-	7	8	6	63
2011	10	5	7	21	-	7	8	6	65
2012	13	5	8	21	-	7	9	6	70
2013	13	6	8	22	-	8	9	7	72
2014	15	6	9	22	-	8	9	7	74
2015	13	6	9	22	-	8	9	7	75
2020	18	8	11	23	-	10	11	8	88
				Average annual growth rate (percent)					
2015–20	5.4%	5.4%	4.9%	0.8%	—	3.8%	2.7%	2.6%	3.3%

Source: IHS Chemical estimates.

The following table presents Southeast Asian consumption for nylon 66 resins:

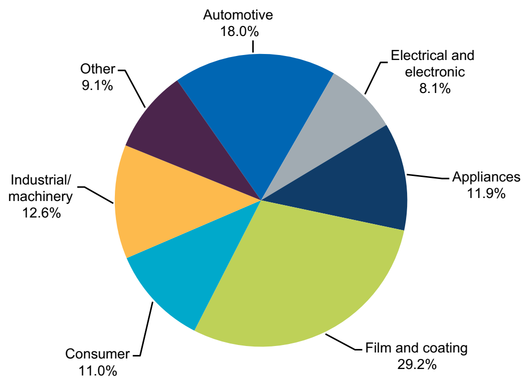
Southeast Asian consumption of nylon 66
(thousands of metric tons)

	Automotive	Electrical and electronic	Appliances	Film and coating	Wire and cable	Consumer	Industrial/ machinery	Other	Total
2005	7	2	1	1	-	3	7	3	23
2006	8	3	1	1	-	4	8	3	27
2007	10	4	2	1	-	5	9	4	34
2008	11	4	2	1	-	6	9	5	37
2009	10	4	1	-	-	5	8	3	30
2010	15	4	-	-	-	5	8	4	36
2011	14	4	-	-	-	5	8	5	36
2012	19	4	-	-	-	5	8	5	40
2013	19	4	-	-	-	5	8	5	41
2014	19	4	-	-	-	5	9	5	42
2015	18	5	-	-	-	5	9	5	42
2020	23	6	-	-	-	6	10	6	49
				Average annual growth rate (percent)					
2015–20	4.1%	5.2%	—	—	—	2.3%	1.7%	2.9%	3.4%

Source: IHS Chemical estimates.

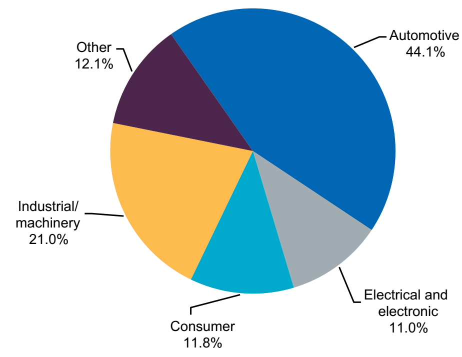
The following charts show the consumption of nylon resin by end use for nylon 6 and nylon 66. The consumption of nylon resins is dominated by automotive applications in Southeast Asia; the second-largest consuming application is film and coating, which consumes a large proportion of nylon 6.

Southeast Asian consumption of nylon 6 by end use—2015



Source: IHS Chemical © 2016 IHS

Southeast Asian consumption of nylon 66 by end use—2015



Source: IHS Chemical © 2016 IHS

Automotive

In 2015, the region produced about 4.1 million vehicles or about 4.5% of the total vehicle production in the world. Total nylon resins consumption for this application was nearly 32 thousand metric tons, with nylon 66 accounting for 58% of the total. In the next five years, Southeast Asia's vehicle production is forecast to grow at about 5.1% per year. In the next five years, demand for nylon resin is expected to grow at around 4.6% per year and reach 40 thousand metric tons by 2020.

Film and coating

The consumption of nylon 6 in film and coating applications is the second-largest demand segment, consuming nearly 22 thousand metric tons of nylon 6, accounting for about 18% of the total consumption of nylon resins in 2015. No nylon 66 is consumed in this application. Consumption of nylon resins for this end use is expected to grow at an average annual rate of less than 1% in the next five years.

Other

Industrial and machinery applications consumed about 18 thousand metric tons of nylon resins in 2015, split nearly equally between nylon 6 and nylon 66. Consumption of nylon resins for industrial and machinery end uses is expected to grow at an average annual rate of about 2.2% in the next five years.

Other applications of nylons are much smaller in volume, but have reasonable growth rates (as shown in the table), suggesting slow, but increased use of nylons in the market.

Trade

The Southeast Asian market has a fair level of domestic demand, but the location and production capacity make the region an ideal player for international trade. Import and export volumes are high for nylon 6 but were almost balanced in 2015; imports were 136 thousand metric tons and exports were 129 thousand metric tons.

Nylon 66 imports of 126 thousand metric tons and exports of 65 thousand metric tons in 2015 make the region a net importer, and it will continue to be so through the forecast period.

Nylon 6 import and export volumes being on par with each other is due in part to the influence of the five countries in the region, as each contributes to the regional supply and has its own trade dynamics. But this trend will shift as the region's imports grow in the future to meet the increased demand.

Appendix I—Markets for modified nylon resins

Property enhancement of nylon and other crystalline/semicrystalline resins are achieved by adding a filler and/or reinforcements. This facility for modification is a very important attribute of nylon resins. Modifications can also be made by adding comonomer during polymerization and by blending a chemically combining nylon with other resins to form alloys. The resin modifications discussed below should continue to provide nylon suppliers with an important means of differentiating their products and extending the price, processing and/or performance ranges of neat resins. In general, higher growth will occur for modified nylons relative to neat nylons.

The following table presents some common fillers and reinforcements and their benefit when added to nylon compounds:

Fillers and reinforcements for nylon compounds

Product	Purpose[a]
Calcium carbonate	Filler, pigment/extender
Calcium sulfate	Extender, enhanced properties
Carbon, graphite fbers	Reinforcement, electrical properties
Glass fiber, cloth, etc.	Reinforcement, dimensional stability
Kaolin	Extender/pigment
Metal fillers, filaments	Electrical properties
Mica	Reinforcement
Microspheres, solid	Flow properties, stress distribution
Polymeric fibers	Reinforcement
Talc	Extender, reinforcement, filler
Wollastonite	Dimensional stability

a. Many products provide a range of functional or appearance properties. Fillers (extenders) frequently provide cost benefits as well as other attributes.

Source: *Plastics Compounding 2005 Redbook*.

Glass reinforced

Glass-reinforced nylon has played an important role in extending the performance capabilities of nylon resins. Glass reinforcement improves strength, stiffness and temperature resistance. Impact strength and dimensional stability are also enhanced. Glass-reinforced compounds are available from most of the major nylon polymer producers, as well as from many independent compounders. The typical reinforcement content is 30–40% (by weight) glass fibers. Semicrystalline nylon (6, 66, 46, aromatic) accepts glass reinforcements very well because polar atoms in the amide linkages promote intermolecular hydrogen-bonding to the glass fibers. In addition, silane coupling agents are usually used to improve the adhesion and/or bonding of the glass to the nylon. The fiber length in glass-reinforced nylons typically ranges from 0.8 to 1.5 millimeters. However, specially made long fiber–reinforced compounds are available with fiber lengths of about 10 millimeters from independent compounders. Long fiber–reinforced compounds are stronger, have higher impact strength, and are more consistent in performance than short-fiber products.

A large majority of glass-reinforced nylon compounds are consumed in the automotive market in applications such as fan blades, fluid reservoirs, valve covers, air cleaners, radiator end tanks, steering column housings, transmission parts, air cleaners, door handles, water pump components, coil bodies, window housings, and oil filter housings. Other important applications for glass-reinforced nylons include valves and gears in the industrial market, housings for gasoline-powered engines (lawn/power tools) in the industrial machinery market, and insulators and coil bobbins in the electrical market. Nearly all of the material is processed by injection molding.

Mineral filled

Mineral-filled nylon is noted for its reduced warpage, increased stiffness, increased heat resistance, and lower price. These materials are available from the major nylon polymer producers and independent compounders. Various minerals can be used including calcium carbonate, calcium sulfate, kaolin, mica, talc, or wollastonite. In most cases, the minerals are surface-treated in order to improve adhesion and/or bonding to the nylon matrix. (For this reason, some manufacturers prefer the term mineral-reinforced to describe these products.) The typical reinforcement content is about 30–40% (by weight) mineral filler. Some mineral-filled compounds also contain glass reinforcements, although in these cases, the mineral filler is usually present in a higher proportion (i.e., 25% mineral to 15% glass).

A variation of mineral-filled nylon is known as nanocomposites. This material, developed by Ube Industries, is a blend of nylon 6 with 1–5% (by volume) montmorillonite clay, which has a particle size on the order of 0.1–0.2 nanometer. The nanocomposite has a tensile and flexural modulus at least twice that of nylon 6 and a heat deflection temperature of almost 146°C (compared with about 66°C for the neat resin). Initial applications for nylon have been in automotive (under-the-hood components, fuel line composite) and in barrier films. Packaging appears to be the growth area for nanocomposites because of increased barrier properties, decreased structure weight, enhanced strength, and better clarity. High growth in barrier packaging applications is anticipated within the next five to ten years.

Approximately 80–90% of mineral-filled nylon compounds are consumed in the automotive market in applications such as fans and fan shrouds, mirror housings, rear end panels and license pockets, door handles, valve covers, air cleaner parts, water pump housings, headlamp housings, transmission control cables and housings, front grilles, and heater parts. Smaller amounts are used in the lawn and power-industrial machinery market in applications such as small engine shrouds, carburetors, and fuel pumps.

Impact modified

The incorporation of impact modifiers into neat nylon results in some of the toughest engineering plastics currently available. The Izod values of certain grades exceed 15 foot-pounds per inch (versus 4 foot-pounds per inch for unmodified nylons), even at very low temperatures. Some of these grades actually show ductile rather than brittle failure. Two major types of impact-modified nylons are now produced, both of which were developed by DuPont. One type contains ionomer resin, while a newer version introduced in 1979 contains an elastomer (primarily EPDM) and is the major type of impact-modified resin. Although DuPont had a strong patent (and market) position in impact-modified nylon, other elastomer-modified products are now offered by a host of other polymer suppliers and independent compounders. Another interesting area of development is the impact modification of nylon resin with a polyether block amide elastomer.

An estimated 50–60% of all impact-modified nylons are consumed in automotive applications such as air dams, gas caps, hood releases, cables and straps, steering column shields, trim clips, oil pans, starter coil-forms, and transmission cables. Consumer items, including bike wheels, toys, roller skates, ice skates, and ski boots, represent a second major market for impact-modified nylons. Small amounts are consumed in hardware and furniture parts, industrial machinery parts, materials handling systems, and other markets for items, such as hammer handles, door striker parts, valve bodies, and oscillating machinery parts. Smaller amounts are also used in electrical connectors and switches. Some impact-modified nylon is also used as an additive concentrate for blending with neat nylons.

Reactor modified

In the production of nylon resins for plastics, as in the production of nylon fiber polymers, additional substances are sometimes added to or reacted with the polyamide in the final stage of polycondensation to improve specific performance properties. Examples of such coreactants are hexamethylene isophthalate or terephthalate, low-molecular-weight polybutylene terephthalate, polyvinyl pyrrolidone, or (with nylon 66) caprolactam. Typical amounts are between 5–10%. However, most commercial resins are homopolymers.

In recent years, various random and block copolymers of caprolactam, hexamethylenediamine, and adipic acid have been introduced, as well as several copolymers using a variety of other monomers. Products of this nature, often with properties comparable with nylon 6 and nylon 66, have been offered by companies such as DuPont, BASF, and DSM.

Nylon 66/6 (triple six) is a copolymer of caprolactam, hexamethylenediamine, and adipic acid. A significant amount of the material is used in power tool housings and furniture applications because of its good surface appearance. Smaller amounts are used in film and monofilament to impart specific properties to the extruded product.

Flame retardant

Unmodified nylon is less flammable than many plastics and is typically rated for flame retardance at UL 94 V-2. To conform to the more rigid UL 94 V-0 specifications, however, additives, such as antimony oxide in combination with highly halogenated organic compounds, can be added to the neat resin. Other flame-retardant nylon systems are also available from various suppliers and they are likely to increase in use, as there are concerns about halogenated systems.

Almost all of the material is consumed in the electrical/electronic market. The major application is in electrical connectors, although smaller amounts are used in switches, relays, and wire.

Other additives

It is also common to blend other additives and materials with nylon to optimize processing and performance properties. Several types of additive compounds are listed below.

- For continuous use at temperatures above 75°C, heat-stabilized grades of nylon 66 containing copper halide or organic stabilizers may be used continuously at temperatures up to 130°C.

- Although neat nylons have a relatively low coefficient of friction, low-friction (lubricated) grades containing molybdenum disulfide, graphite, or polytetrafluoroethylene (PTFE) are sometimes used in applications such as gears, bearings, bushings, and cams. These grades are marketed primarily by specialized compounders.

- Plasticizers such as certain sulfonamides (e.g., n-butylbenzene sulfonamide [BBSA]), glycols, and benzoic acid esters are sometimes used to impart flexibility for applications such as tubing. Plasticizers are usually used in relatively minor proportions, at levels under 10%. For example, nylon 12 resins are typically plasticized for tubing applications. Small amounts of unreacted caprolactam can also act as a plasticizer for nylon 6 in wire and cable applications.

- The use of colorants is common in nylons.

- For use in automobile fuel systems, conductive nylon12 grades with stainless steel fibers are used for injection-molding or extrusion applications. Where static charge buildup in fuel injection systems is undesirable, material has been qualified for use in fuel filters.

Appendix II—Nylon alloys

Since the mid-1980s, a number of nylon alloys have been developed. Nylon alloys can be characterized by differences in heat resistance, impact resistance, chemical resistance, moisture absorption, and ease of processing. Most nylon alloys are consumed in small volumes (with the exception of nylon/polyphenylene ether). In the near future, except for nylon-PPE, significant amounts of nylon resins are not foreseen to be consumed in alloys. The future growth of these materials is limited by the cost of making compatible blends. In this report, there is no significance to the order in which the constituent resins appear in the generic name of a particular alloy.

Nylon/polyphenylene ether

Introduced in 1984, nylon/polyphenylene ether (PPE) has a combination of properties especially well-suited to niche markets in the automotive industry. In particular, the excellent temperature resistance of this material allows it to withstand the high temperatures of on-line painting. Alloying semicrystalline nylon with PPE promotes good melt flow and improves resistance to organic solvents, helping to overcome drawbacks that are common to amorphous resins such as PPE. In addition, water absorption of the nylon is reduced in proportion to the amount of PPE in the alloy. This alloy was tailored for use in exterior body panels, but over the last few years has been increasingly utilized in other automotive applications including wheel covers, air cleaners, and fuse/junction systems. In this latter case, there has been some substitution of polypropylene-based products. For additional information on nylon/PPE alloys, see the CEH *Polyphenylene Ether Resins/Alloys* report.

Nylon/ABS

Nylon/ABS alloys are superior in toughness and weatherability to either of the two base materials. The material is used in a variety of applications such as industrial power tools, garden equipment, appliances, sporting goods, and industrial components. Both ABS and nylon are basically incompatible and can be compatibilized with compounds such as Kraton®, a styrene–methyl methacrylate–maleic anhydride copolymer.

Nylon/silicone semi-interpenetrating networks

Semi-interpenetrating networks (semi-IPN) are multicomponent materials, similar to alloys, although they differ in that one component of the compound is a thermosetting polymer that is cross-linked in the presence of a thermoplastic resin. The two components are not miscible but instead are bound by entanglements formed during melt processing and/or molding by means of chemical reaction. Both components remain present in continuous phases.

Nylon/polyolefin

Alloys of nylon with polypropylene provide lower moisture absorption and, thus, greater dimensional stability for tighter tolerances in molded parts. Alloys of nylon have also been made with low-density polyethylene (LDPE), linear low-density polyethylene (LLDPE), and/or high-density polyethylene (HDPE). Uses include automotive wheels, cable insulation, paddles for use in sporting events, and tubing. Product is largely supplied by Arkema (Orgalloy®) or independent compounders.

Although it cannot be considered an alloy, a nonhomogeneous blend of nylon and polyethylene can be made using an amorphous nylon material from DuPont known as Selar® RB. Used for food packaging and fuel tanks, low concentrations of Selar® RB provide excellent barrier properties by forming platelets of nylon within the HDPE matrix. Using conventional processing equipment, it forms a multilayer (laminar) barrier when blow molded into a container.

A major use of Selar® RB is for gasoline tanks in Europe where permeability restrictions are not as stringent as in the United States. DuPont also produces an acrylic nylon alloy, having good low-temperature toughness, good heat aging, and good chemical resistance. Uses include cable jacketing and hose and tubing applications.

Nylon/polyethylene terephthalate

A nylon/polyethylene terephthalate (PET) alloy was formerly being developed by Honeywell for use in wire and cable, business machines, under-the-hood auto parts, appliances, and electrical/electronic components. This development was terminated in the mid-1990s.

Nylon/polyarylate

In this system, polyarylate contributes to improving heat resistance, water absorption, and dimensional stability, while nylon contributes to improving chemical resistance, impact resistance, and processibility. The system, which is available from Unitika, targets the automotive industry.

Nylon/polycarbonate

Nylon/polycarbonate (PC) blends were first introduced in 1986 by Research Polymers (then part of The Dexter Corporation). Theoretically, these blends combine the high heat resistance and low moisture resistance of PC with high chemical resistance, abrasion resistance, and toughness of nylon. The addition of nylon to the PC improves tolerance to coating solvents and gasoline, making the blends suitable for exterior automotive applications. Nonautomotive target markets include business machine housings, sterilizable hospital trays, and food processing equipment. Nylon/PC may also be used in blow-molding applications. A polyester/polyamide block copolymer and a polyolefin grafted with maleic anhydride can be used as compatibilizers.

Nylon/polystyrene

Metallocene polystyrene and nylon 66 alloys have been produced with 30% glass loading.

Nylon/PTFE

To increase lubricity properties, poly(tetrafluoroethylene) (PTFE) can be added to nylon; the PTFE readily migrates to the surface, and is, thus, very effective in modifying surface properties. These blends are sold by specialty compounders.

Bibliography

IHS Chemical Economics Handbook—The following CEH reports contain additional information that is pertinent to the subject of this report:

Adipic Acid
Caprolactam
Hexamethylenediamine (HMDA)/Adiponitrile (ADN)
Nylon Fibers
Polyamide Resins (Nonnylon types)
Polyphenylene Ether Resins/Alloys
Specialty Organic Fibers

IHS Chemical Process Economics Program—The following Process Economics Program reports contain more detailed information on the manufacturing processes, process design and process economics of the chemicals discussed in this report. Address inquiries concerning this information to the Process Economics Program, IHS Chemical, Santa Clara, California 95054.

Bio-based Adipic Acid, Report No. 284, December 2012.

Blends Containing Engineering Thermoplastics, Report No. 175B, July 1991.

High-Temperature Polymers, Report No. 86F, March 1994.

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Polyamides Other Than Nylons 6 and 66, Report No. 94, November 1974.

Specialty Polyamides 11 and 12, Report No. 94A, December 2013.

IHS Specialty Chemicals Update Program—The following SCUP reports contain additional information that is pertinent to the subject of this marketing research report. Address inquiries concerning this information to the Specialty Chemicals Update Program, IHS Chemical, Santa Clara, California 95054.

Compounding of Engineering Thermoplastics
High-Performance Thermoplastics
Specialty Films

IHS Chemical World Analyses—Additional worldwide data on nylon engineering resins are included in the World Analysis—*Nylon Engineering Resins* report. Address inquiries concerning this information and other World Analysis reports to World Analysis, IHS Chemical, Houston, Texas 77077.

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