Description

Image

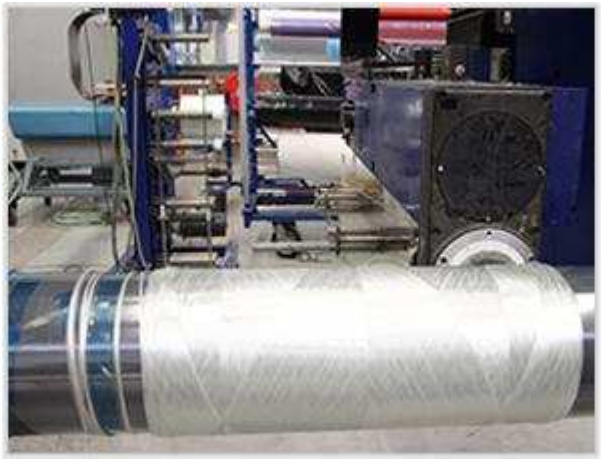




Image caption

(1) Plastic filament for filament winding © Granta Design at TU Delft University (2) Filament winding in action © Granta Design at TU Delft University (3) Final tube result of the resin and the plastic filament © Granta Design at TU Delft University

The process

In FILAMENT WINDING, axisymmetric parts are produced by winding the resin-impregnated reinforcement (rovings or tape) on a rotating mandrel made of steel or plaster. The winding pattern -- helical, hoop or polar -- is chosen to maximized the performance of the application. A multi-axis winding spindle is used for winding more complex shapes. Winding is continued until the desired material thickness has been achieved. The component is pulled off the mandrel as soon as it has hardened. The high volume fraction of continuous reinforcement results in products with high strengths.

Process schematic

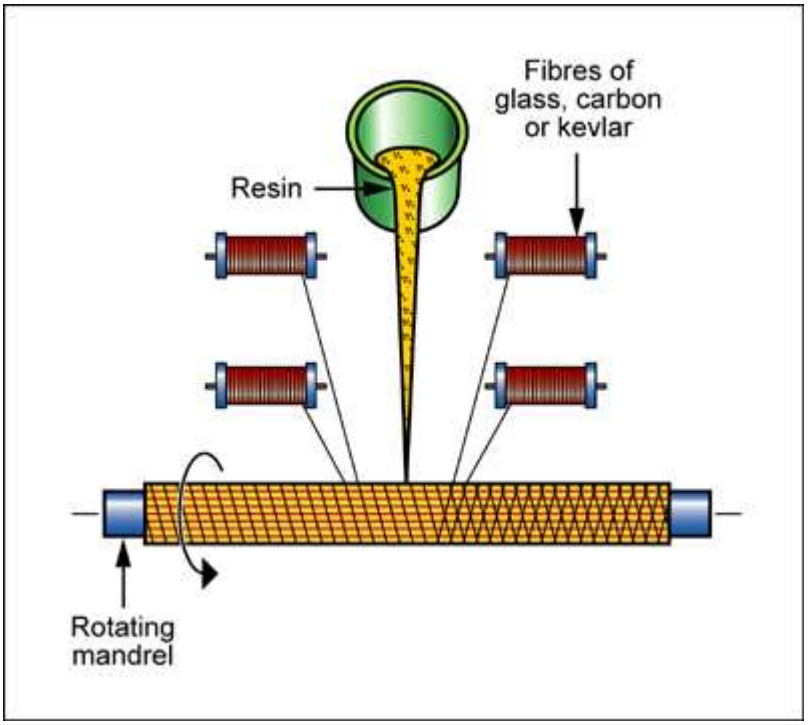


Figure caption

Filament winding of a hollow tube.

Material compatibility

Composites	✓			

Shape

Circular prismatic	✓			
Non-circular prismatic	✓			
Hollow 3-D	✓			

Economic compatibility

Relative tooling cost	low			
Relative equipment cost	high			
Labor intensity	medium			
Economic batch size (units)	1	-	1e4	

Physical and quality attributes

Mass range	0.01	-	3e3	kg
Range of section thickness	2	-	25	mm
Tolerance	* 0.5	-	1.6	mm
Roughness	* 0.5	-	1.6	µm
Surface roughness (A=v. smooth)	A			

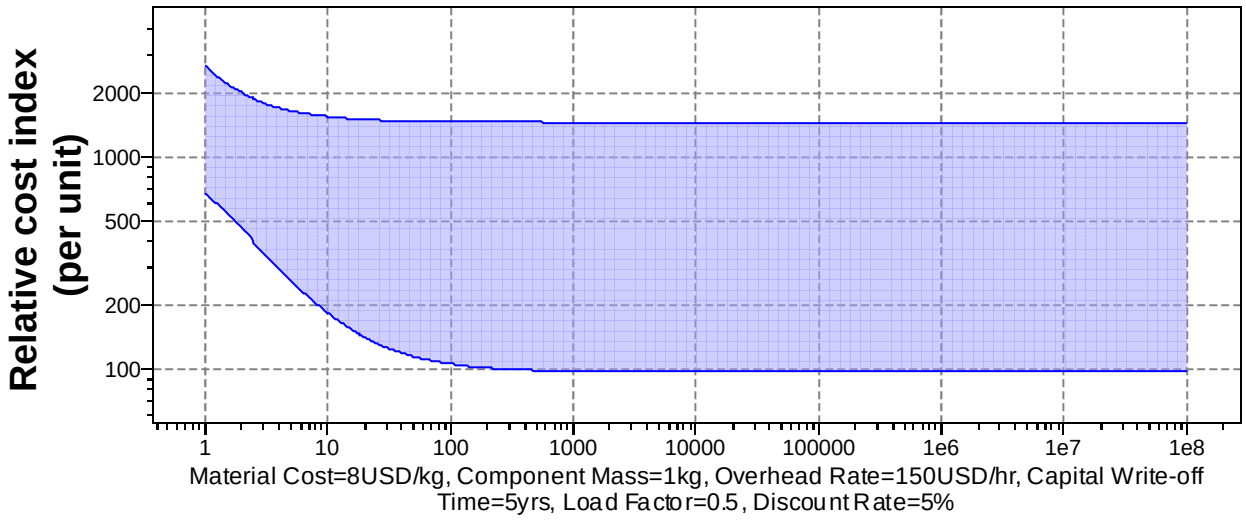
Process characteristics

Primary shaping processes	✓			
Discrete	✓			
Prototyping	✓			

Cost model and defaults

Relative cost index (per unit)	* 97.2	-	1.46e3	

Parameters: Material Cost = 8USD/kg, Component Mass = 1kg, Batch Size = 1e3, Overhead Rate = 150USD/hr, Discount Rate = 5%, Capital Write-off Time = 5yrs, Load Factor = 0.5



Capital cost	* 3.28e4	-	8.2e5	USD
Material utilization fraction	0.8	-	0.95	
Production rate (units)	0.12	-	2	/hr
Tooling cost	164	-	1.64e3	USD
Tool life (units)	* 1e3	-	1e4	

Supporting information

Design guidelines

Filament winding is best suited for making axisymmetric hollow parts and convex shell structures. External ribs, metal inserts and foam panels are possible but bosses and undercuts are not.

Technical notes

Common used resin systems include liquid polyesters and epoxies. Epoxy-carbon prepreg can be wound as tape. Reinforcement is usually glass (volume fraction 60-80%) carbon or aramid, either in the form of rovings or tapes.

Typical uses

Tanks, pipes, tubes, pressure vessels, drive shafts, wind turbine blades, rocket noses, tubing for light-weight bicycles and space-frames.

The economics

The process is relatively expensive but gives products of exceptionally high

The environment

Filament winding often uses low viscosity resins. These are more hazardous than other, thicker, resins because of the toxic vapor they release, making forced-air ventilation necessary.

Links

MaterialUniverse

Reference