NBR (Nitrile Rubbers)

General information

Strengths

NBR: Resistance to aliphatic hydrocarbon oils and fuels up to 100-120 °C (210-250 °F). Wear resistance, resilience.
NBR (hydrogenated): Improved temperature resistance, mechanical properties, and aging than standard NBR. Good mechanical properties include strength, elongation, tear, abrasion resistance, compression set, and extrusion resistance. Saturated grades have excellent ozone resistance.
NBR (carboxylated): Compared to standard NBR, carboxylated nitrile (XNBR) has higher mechanical properties, especially abrasion resistance and toughness, also strength and modulus.

Limitations

NBR: Weathering, oxidation/ozone attack, aromatic oils, modest strength. Relatively poor electrical properties (e.g. poor insulation).
NBR (hydrogenated): Poor resistance to aromatic hydrocarbons, high cost.
NBR (carboxylated): Poorer low temperature flexibility, resilience (higher tan delta), and compression set than standard NBR. Improved mechanical properties drop off with increasing temperature.

Designation

Nitrile rubber / Acrylonitrile butadiene copolymer (NBR).
Hydrogenated nitrile rubber / Hydrogenated acrylonitrile butadiene copolymer (HNBR / H-NBR).
Carboxylated nitrile rubber (XNBR / X-NBR).

Tradenames

NBR: Buna-N, Perbunan, Krynac, Baymod N, NBR Nipol, Breon, Chemigum, Europrene N, Hycar, Nysyn, KER, Humex, JSR, Kosyn KNB, Nitriflex N, Arnipol, Chemaprene, Paracril, Polyblack
NBR (hydrogenated): Therban, Tornac, Zetpol
NBR (carboxylated): Nipol (former Chemigum) NX775

Typical uses

NBR: Automotive, seals, fuel and oil hose, gloves.
NBR (hydrogenated): Automotive fuel seals and systems, oil field seals, automotive belts, high performance shoe soles.
NBR (carboxylated): Military & industrial footwear, non-slip stair treads, printing rolls, seals where toughness and oil resistance are required.

Composition overview

Compositional summary

NBR: Copolymer of 50-82% butadiene and 18-50% acrylonitrile (common abbreviation: ACN), (CH2CH=CHCH2)n, (CH2CH(CN))m. Most common ACN content is 32-35%. Can be reinforced by carbon black, and plasticizer may be added.
NBR (hydrogenated): Copolymer of 50-82% butadiene and 17-50% acrylonitrile (ACN), partially or fully hydrogenated to remove double bonds (i.e. to 'saturate'). Partial = 2-18% residual double bonds, saturated = <0.9%. Most common ACN content is 34-36%. Typically cured with organic peroxide or sulfur/sulfur donor systems. 25-40% carbon black and 5-10% plasticizer may be added.
NBR (carboxylated): Copolymer of butadiene, 26-33% acrylonitrile (ACN), (CH2CH=CHCH2)n, (CH2CH(CN))m, and a small amount of carboxylated monomer. Typically sulfur cured. 25-33% carbon black, 5-10% plasticizer, 3% zinc oxide may be added.

Material family	Elastomer (thermoset, rubber)
Base material	NBR (Nitrile butadiene rubber)

Effect of composition

NBR: Acrylonitrile content increases strength, chemical resistance, Tg and heat resistance, and reduces low temperature flexibility, resilience, die swell, and gas permeability. Tg is -60 °C (-76 °F) at 20% ACN, -35 °C (-31 °F) at 34%, and -10 °C (14 °F) at 48%.
NBR (hydrogenated): Properties of HNBR can be tailored by both the level of the acrylonitrile content and the degree of hydrogenation. Higher acrylonitrile content increases strength, chemical resistance, Tg and heat resistance, and reduces low temperature flexibility, resilience, die swell, and gas permeability. Saturation maximizes high temperature performance and aging.
NBR (carboxylated): The carboxylate groups allow additional ionic crosslinking, typically using zinc (Zn2+) ions, resulting in enhanced properties. However, the improved mechanical properties drop off with increasing temperature as the ionic crosslinking introduced by carboxylation is more thermally sensitive than the covalent crosslinking of standard vulcanization.

Processing properties

First commercial production	1939

Forming

NBR: Suitable for extrusion, calendering, compression, transfer and injection molding. High-acrylonitrile content NBRs exhibit better calendering and extrusion properties. Only small parts can be compression molded at high temperatures (larger ones possible at lower temperatures).
NBR (hydrogenated): Suitable for injection molding and extrusion. Relatively easy to mill though builds heat quickly, requiring cooling facilities.