Caoutchouc Industriel

ELASTOMONT

Industrial Rubber

RUBBER DEMYSTIFIED

Glossary & practical guide to understand, specify, and purchase rubber parts

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Contents

Why this document?

This guide demystifies the technical vocabulary used when designing, buying, and manufacturing rubber parts. It helps you read a rubber datasheet, choose an elastomer based on the service environment (oil, UV, heat, steam, chemicals), and write a clear, supplier-ready specification.

1. Fundamentals

1.1 What is an elastomer?

Rubber (an elastomer) is a material capable of large, mostly reversible deformation. You can compress it, stretch it, and it returns (to a large extent) to its original shape. This behavior comes from long polymer chains and a crosslinked network created during curing.

1.2 Vulcanization / curing (the “cook”)

Vulcanization (curing) converts an uncured compound into a durable elastomer. Crosslinks are formed between polymer chains using a cure system (sulfur, peroxide, etc.) and heat. Cure state directly impacts hardness, strength, compression set, odor, and dimensional stability.

1.3 Natural vs synthetic rubber

• NR (natural rubber): excellent resilience and tear resistance, but sensitive to UV/ozone.
• Synthetic elastomers (EPDM, NBR, FKM, VMQ, etc.): engineered for better oil, heat, chemical, and weathering resistance.

2. Elastomers & materials (choosing the right ingredient)

Temperature ranges and compatibility are indicative. They vary with formulation, hardness, fillers, cure system, and the real fluid (composition, pressure, additives). Always validate with the supplier for your exact service conditions.

2.1 Quick selection table

Material	Strengths	Limitations	Typical service temp.	Common uses
EPDM	Weathering, UV/ozone, hot water, steam	Poor with oils/fuels	-40 to 120°C	outdoor seals, water/steam

NBR (Nitrile)	Oils, greases, fuels (grade-dependent)	UV/ozone aging; limited steam	-30 to 100°C	hydraulics, O-rings
FKM (Viton®)	High heat + aggressive chemicals + fuels	High cost; limited low-temp flexibility	-20 to 200°C	chemical, engines, fuels
VMQ (Silicone)	Excellent low-temp flexibility; high heat; inert	Lower tear/abrasion; higher cost	-60 to 200°C	food, medical, ovens
CR (Neoprene)	Versatile; good weathering; flame behavior grade-dependent	Not as good as NBR in oils; moderate chemical resistance	-35 to 100°C	guards, vibration damping
HNBR	Upgraded NBR (better heat/ozone)	More expensive than NBR	-30 to 150°C	automotive, demanding hydraulics
IIR (Butyl)	Very low gas permeability	Limited oil resistance; specific bonding needs	-40 to 120°C	inner tubes, pharma stoppers
PU/TPU	Very high abrasion and cut resistance	Hydrolysis possible (chemistry-dependent); higher stiffness	-30 to 80°C	wheels, scrapers, wear parts

3. Mechanical & physical properties (reading a datasheet)

3.1 Hardness (Shore A / Shore D)

Shore hardness measures resistance to indentation. Most elastomers are specified in Shore A. Shore D is used for harder materials (some polyurethanes, plastics).

Range	Feel	Examples
20–40 A	very soft	soft dampers, foam seals
50–70 A	standard	seals, mounts, general parts
80–95 A	very firm	wheels, scrapers, anti-extrusion

3.2 Tensile, elongation, modulus

• Tensile strength: maximum stress before break (MPa or PSI).
• Elongation at break: % stretch at rupture.
• 100% / 300% modulus: stress required to reach 100% (2×) or 300% (4×) elongation. This indicates “stretch stiffness” (different from hardness).

3.3 Deformation, memory and energy losses
- Compression set: % permanent deformation after compression + time + temperature. Lower is better for sealing.
- Creep: slow deformation under constant load.
- Hysteresis: energy dissipated as heat during deformation cycles (useful for damping, harmful for heat build-up).

3.4 Service-related properties
- Abrasion resistance: ability to withstand wear.
- Cut / nick resistance: ability to resist crack initiation from sharp edges.
- Swell: volume change after fluid absorption.
- Specific gravity: useful for part weight, material yield and cost per part.
- Permeability: gas transmission through rubber (important in pressure service).

3.5 Advanced properties (demanding applications)
- TR10: temperature at which a pre-stretched sample recovers 10% retraction.
- Glass transition (Tg): region where rubber becomes stiff/brittle.
- Dielectric strength: insulating performance.
- Resilience: energy return (bounce), linked to damping and heat build-up.

4. Manufacturing processes
- Injection molding: heated compound injected under pressure; ideal for high volumes and complex geometries.
- Compression molding: charge placed in mold, pressed and cured; cost-effective for small/medium volumes.
- Transfer molding: between compression and injection; useful for inserts and certain designs.
- Extrusion: continuous profiles through a die; tubing, seals, cords.
- Post-cure: additional oven cure to stabilize/improve properties for certain elastomers/specs.
- Deflashing: removal of flash (manual, mechanical, or cryogenic).

5. Common rubber part types
- O-ring: common seal for static/dynamic use.
- Lip seal (oil seal / SPI): dynamic sealing on shafts.
- X-ring (quad-ring): X-shaped cross-section; reduces twist and improves stability.
- Rubber-to-metal mount (silentblock): vibration and shock isolation.
- Grommet: protects cables through sheet metal.
- Bellows: protects moving mechanisms.
- Back-up ring: rigid ring to prevent seal extrusion under pressure.
- Extruded profile: door seals, wear strips, lips, beads, cords.

6. Defects, quality and inspection

6.1 Common defects
- Porosity / voids: internal bubbles; weakens parts and may cause leaks.
- Burn marks (diesel effect): blackened areas from trapped/compressed air; often linked to poor venting.
- Flash: thin excess at parting line.
- Short shot / non-fill: incomplete part.
- Knit lines: flow fronts meet; can be a weakness.
- Blistering: surface bubbles; volatiles or trapped air.
- Sink marks: local depressions due to internal shrinkage.
- Delamination: separation in layers; contamination, poor mixing or cure issues.
- Bloom: additive migration to surface; acceptable or not depending on bonding/painting requirements.

6.2 Under-cure / over-cure

• Under-cure: low strength, higher odor, fast deformation.
• Over-cure: harder and sometimes more brittle; accelerated cracking.
Process settings are ideally supported by rheometer cure data (cure curve, T90).

7. Sealing: static vs dynamic

A static seal does not move: chemical compatibility and compression set are priorities. A dynamic seal moves: friction, heat build-up, wear and assembly tolerances become critical.

7.1 Key terms

• Squeeze: % compression of the seal in assembly.
• Stick-slip: alternating adhesion and slip; causes noise/vibration.
• Gap / clearance: metal-to-metal clearance; critical under pressure.
• Back-up ring: prevents extrusion into the gap.
• Coefficient of friction: affects wear, heat, and actuation force.

8. Failure analysis

• Compression set failure: flattened seal, loss of contact, leakage.
• Gap extrusion: “feathering” opposite the pressure side; gap too large or compound too soft.
• Spiral failure: O-ring twist in reciprocating motion; spiral tear.
• Rapid gas decompression (RGD): internal cracking and rupture after a sudden pressure drop.
• Chemical attack / swell: softening, cracking, dimensional loss.
• Ozone/UV aging: surface cracking, often under strain.

9. Lab tests and useful standards

• ISO 3302: dimensional tolerances for molded rubber parts.
• ASTM D2000: classification system for elastomer compounds (widely used).
• FTIR: quick elastomer family identification.
• TGA: estimates composition fractions (polymer, oil, carbon black, ash).
• Accelerated aging (UV/ozone/heat): stability and cracking.
• Abrasion testing: comparative wear.
• Bond tests (peel / lap shear): rubber-to-metal adhesion performance.

10. Purchasing checklist and specification template (STAM)

Before requesting a quote or approving a material, define the application clearly. This checklist prevents most specification errors.

Item	What to define
S – Stresses	Compression, tension, abrasion, impact, cycle frequency, speed, load
T – Temperature	Continuous temperature, peaks, extreme cold, thermal gradients, heat sources
A – Atmosphere	Water/steam, oil, fuel, solvent, acid/base, abrasive dust, UV/ozone, pressurized gas

M – Memory / life	Critical sealing?, target life, maintenance possible, storage constraints

10.1 Specification template

Part: _____ (drawing / 3D / sample)
Quantity (lot / annual): _____
Material requested (or constraints): _____
Hardness: _____ Shore A (tolerance: ± ___)
Dimensional tolerances: ISO 3302 class ____ (or specify)
Environment: _____ (fluid, concentration, temperature, pressure)
Application: static / dynamic (rotary / reciprocating) – speed: _____
Key requirements: max compression set ____ %, abrasion ____ , color ____ , finish ____
Quality / certificates: _____ (test report, lot traceability)
Packaging / marking: _____

Alphabetical glossary (A–Z)

Accelerator: Additive that speeds up vulcanization (reduces cure time).

Adhesion: Ability to bond to a substrate (metal, fabric, other elastomer) depending on the bonding system.

Anti-ozonant / antioxidant: Additives that slow aging from ozone, oxygen and heat.

ASTM D2000: Elastomer compound classification system widely used in industry.

Back-up ring: Rigid ring that prevents a seal from extruding into a clearance gap under pressure.

Batch / lot: Production identification enabling material and process traceability.

Bloom: Migration of waxes/additives to the surface; may be acceptable or not depending on bonding/painting.

Burn mark (diesel effect): Black mark from trapped/compressed air; often related to insufficient venting.

Carbon black: Reinforcing filler; improves abrasion and tensile properties and adds UV protection.

Coefficient of friction: Key factor for wear, heat build-up and actuation force in dynamic seals.

Compression set: Permanent deformation after compression + time + temperature; critical for sealing.

Creep: Slow deformation under constant load.

Cure / vulcanization: Crosslinking reaction that forms the elastomer network.

Deflashing: Removal of flash after molding (manual, mechanical or cryogenic).

Delamination: Separation into layers; contamination, poor mixing or cure issues.

Dielectric strength: Electrical insulating capability.

Draft angle: Taper that helps demolding.

Durometer: Instrument used to measure Shore hardness.

Elongation at break: Percent elongation at rupture.

Extrusion: Process creating continuous profiles through a die.

FKM: High-performance fluoroelastomer (often Viton®) for heat and chemical resistance.

Flash: Thin excess material at the parting line.

Flow line: Surface mark from flow; distinct from structural knit lines.

FTIR: Infrared spectroscopy used to identify elastomer family.

Glass transition (Tg): Region where rubber becomes stiff/brittle.

Grommet: Rubber insert protecting a cable through sheet metal.

Green strength: Strength of uncured compound; impacts handling and process.

HNBR: Hydrogenated nitrile with improved heat/ozone resistance vs standard NBR.

Hysteresis: Energy loss as heat during cyclic deformation.

Insert: Typically metal component placed in mold; rubber cures around it (overmolding).

ISO 3302: Dimensional tolerances standard for molded rubber parts.

Knit line: Where two flow fronts meet; can be a weakness.

Lip seal: Dynamic shaft seal with a flexible lip.

Mooney viscosity: Measure of uncured compound viscosity/consistency.

Modulus (100% / 300%): Stress required to reach 100% / 300% elongation.

MOQ: Minimum order quantity driven by setup/start-up costs.

NBR: Nitrile rubber; good oil and grease resistance.

Non-fill / short shot: Incomplete part due to insufficient fill.

O-ring: Common seal ring for static/dynamic sealing.

Parting line: Visible line where mold halves meet.

Peel strength: Adhesion strength measured in peel; used for rubber-to-metal bonding.

Peroxide cure: Cure system used for certain performance requirements.

Porosity / voids: Internal bubbles/voids; weakens and may leak.

Post-cure: Additional oven curing step to stabilize/improve properties.

Primer: Bonding layer used in rubber-to-metal adhesion systems.

Rapid gas decompression (RGD): Internal damage after sudden pressure drop (microcracks/rupture).

Resilience: Energy return (bounce); linked to damping and heat build-up.

Scorch: Premature curing before full mold fill; leads to defects/scrap.

Specific gravity: Relative density used for weight/yield calculations.

Swell: Volume change after fluid absorption.

T90: Time corresponding to ~90% cure on a rheometer curve; commonly used for cycle setting.

Tack: Surface stickiness of uncured compound; affects building and handling.

Tear strength: Resistance to crack growth from a cut or notch.

TGA: Thermogravimetric analysis estimating composition fractions.

TR10: Retraction temperature at 10% recovery after stretching; indicator of low-temp behavior.

Undercut: Geometry preventing straight demolding; requires tooling actions or deformation.

VMQ: Silicone rubber with excellent low-temp flexibility and high-temp stability.

X-ring (quad-ring): X-shaped seal that reduces twist and improves stability in dynamic service.