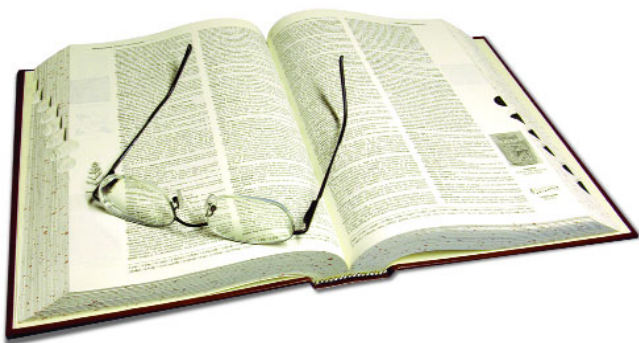


Section 7

Glossary



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Glossary

Abrasion: Surface wear caused by relative motion between contacting objects

Age Protection, Active: The use of a chemical additive in a rubber compound which is preferentially attacked by oxygen or ozone thereby sacrificially protecting the rubber.

Age Protection, Passive: The use of a chemical additive in a rubber that will migrate to the surface of a rubber part to form a protective physical barrier.

Aging: The change in physical and chemical characteristics of a rubber compound that has been exposed to a particular environment over time.

Axial: Directed along, or parallel to, an axis. With a seal ring, the axial direction is perpendicular to the plane of the seal, and would be described as the "up and down" direction if the seal ring were to be placed flat upon a desktop.

Backup washer: A washer made from certain material that will add strength or support when installed next to the seal. This prevents the seal from being pinched and evenly distributes the load.

Bore: A hole in a component which permits the passage of a shaft.

Bore Seal: A sealing system, usually in a radial orientation, in which the primary sealing surface is between the O.D. of a seal ring and the I.D. of a bore.

Cavity: The features of a mold which are directly responsible for forming the final shape of a molded part. Mold cavities are formed from two or more mating components of a mold.

Chemical bonding: A method for bonding rubber to secondary parts by applying special adhesives to the part prior to molding.

Circularity: The form tolerance of the surface of a molded or ground ball in reference to a perfect sphere. Also referred to as "roundness."

Clearance (in a sealing system): The space between components in a mechanical system which is present to allow for manufacturing, thermal, and dynamic variations in the size and position of the components. As measured, it is equal to the distance between the sealing surface and the entrance to the seal groove. In a radial sealing system, this will be the space between the O.D. of the shaft or piston and the I.D. of the bore. As the clearance in a system increases, the tendency of the seal to dislodge from the groove and enter into the clearance space also increases, especially in applications where pressure is present. Care should be taken in radial applications to note whether clearances are being stated as radial clearances or as diametral clearances.

Closure Dimension: Any dimension assigned to a feature of a molded part which is parallel to the direction of mold travel and formed by mating cavity components carried on two or more separate mold plates. A closure dimension, by this definition, always spans or references a mold parting line. Closure dimensions typically have larger associated tolerances because of the additional accumulated tolerance due to the creation of the feature from separate, movable, parts of the mold.

Coating: A uniform layer of chemical primers or adhesives applied to a surface to produce a chemical bond between the rubber and substrate. May also refer to special surface treatments that can be applied to rubber to achieve desired properties.

Cold Deck: A component of a mold which is responsible for cooling a cold runner system.

Cold Runner: A molding system whereby material being transferred through the mold's runner is cooled to prevent it from vulcanizing prior to entrance into the mold cavity. This reduces material usage by eliminating the waste of the material which would otherwise vulcanize inside the runner.

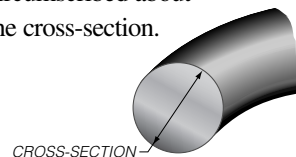
Compound: A mixture of a polymer and associated chemical ingredients necessary to produce a finished rubber material. The term is commonly used when referring to a specific rubber formulation.

Compression Molding: A molding process in which the uncured rubber compound is placed directly into the mold cavity, and compressed to its final shape by the closure of the mold.

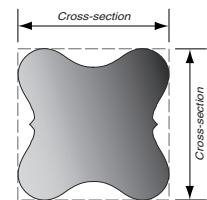
Compression Set: The amount of permanent deformation experienced by a rubber material when compressed for a period of time. The term is commonly used in reference to a test conducted under specific conditions wherein the permanent deformation, expressed as a percentage of the original deflection, is measured after a prescribed period of time. A low compression set is desirable in molded rubber parts such as seals and gaskets, which must retain their dimensions to maintain an effective seal. Compression set is the "end-product" of the process of stress relaxation.

Cross-linking Agents: A chemical or chemicals that bond the polymer chains of a rubber together during the molding process.

Cross-section (of a seal): The axial thickness or radial width of an O-Ring or Quad-Ring seal. For an O-Ring, this will be the circular diameter of its cross-section. For a Quad-Ring, this will be the length of a side of a square circumscribed about the cross-section.



O-Ring Cross-section



Quad-Ring® Cross-section

Cross-sectional Reduction (of a seal): The reduction in thickness of a seal's cross-section as a result of material displacement caused by an applied stretch to the seal. (*See also Necking*)

Cross-sectional Compression, Percent (of a seal): The deformation placed on a rubber part to affect a seal. It is expressed as a percentage of the seal's original (undeformed) cross-section. (*See also Squeeze*)

Crush Bead: A deformable feature, normally taking the form of a continuous, small, hemispherical radius, on an insert which is used to help control which surfaces of the part will be covered by rubber during the molding process. During the molding process as the mold closes on the insert, the crush bead is deformed, creating a tight seal which confines rubber to the desired area of the part.

Crush Ring: *See Crush Bead*

Curing: An informal (slang) term for the vulcanizing process that cross-links a rubber to form its characteristic elastic properties. (*See also Vulcanization*)

Damping: The ability of an elastomer to absorb forced vibrational energy.

Deflashing: Any of various processes used to remove extraneous rubber from a molded rubber part.

Durometer: Standard rubber industry term for hardness, which uses an indenter to measure the hardness of molded rubber. While other scales are available, the hardness of rubber is most commonly reported by a durometer using the Shore A scale.

Dynamic Seal: A seal used in an environment that subjects it or a mating surface to movement.

Ejector Pin: A moving pin or set of pins used to remove, normally by pushing, a finished part from a mold cavity at the conclusion of the molding cycle.

Elasticity: A rubber's ability to return to its original size and shape after removal of the stress causing deformation such as stretching, compression, or torsion. It is the opposite of plasticity. The term elasticity is often loosely employed to signify the "stretchiness" of rubber.

Elastomer: Any of various polymers having the elastic properties of rubber.

Extrusion: When part or all of a component is forced from its groove by high continuous or pulsating pressure.

Face Seal: A sealing system in which the sealing occurs in the axial direction of the seal. If the seal ring were to be placed flat upon a desktop, the seal compression would occur between the top and bottom of the seal.

Feather Edge: The sharp, thin edge on parts such as wiper seals and cups. Also called a "knife edge."

Filler: An ingredient added to a rubber formulation. Carbon black and silica are common fillers used in rubber compounds.

Fixed Dimension: Any dimension assigned to a feature of a molded part which is formed from a part of the mold which is machined into a single mold cavity component. Fixed dimensions, since there are fewer variables affecting the formation of the part's feature, typically have smaller associated tolerances than closure dimensions.

Flash: Extraneous material protruding from the surface of a molded part. Flash is generally found on a molded part at the parting line locations.

Flexural strength: The ability of a material to flex without permanent distortion or breaking.

Flow: The movement of heated plastic or uncured rubber to travel in the mold and runner systems during the molding process.

Flow Line: A disturbance in the homogeneous structure of a molded part generally caused when material knitted or blended with itself during the molding operation.

Gasket: A seal used in a static application, where the seal is effected by clamping the gasket between two rigid, flat surfaces. Gaskets can be made from many different types of materials, including paper, plastic, cork, rubber, metal, or a combination thereof.

Gates: The openings in an injection or transfer mold whereby material enters the mold cavity.

Gate Mark: A raised spot or small depression on the surface of an injection or transfer molded part where the gates interface the cavity. (*See also Sprue Mark*)

Gland: The space in a mechanical system into which a seal is installed. The gland consists of the seal groove and any additional space required to achieve the proper compression of the seal. Care should be taken to distinguish between the terms gland and groove, which are separate but related concepts

Gland Depth: The gland depth (pictorially depicted and described as Dimension "C" throughout this book) is the distance from the sealing surface to the seal groove surface. The gland depth determines how much the seal is compressed and therefore how much cross-sectional compression (squeeze) is applied to the seal. In a radial sealing application, the gland depth is used to calculate the seal groove diameter by either adding or subtracting (depending on the type of seal) twice its value from the diameter of the sealing surface. In an axial (face) sealing application, the gland depth equals the groove depth when it is a zero clearance application (two directly contacting surfaces, such as a cover) or, when clearance is present, it is the distance from the sealing surface to the seal groove surface (such as in a rotary face seal

Glossary-continued

application). It should be noted that the Gland depth and the Clearance are separate sealing system parameters and a change in one of these parameters does not result in a change to the other. For example, if the clearance in a system needed to be increased, the required gland depth to achieve the desired seal compression would remain the same, but the seal groove diameter would need to be adjusted to achieve the desired gland depth. Care should also be taken to distinguish between the terms gland depth and groove depth, which are separate but related concepts. See the Application section of this publication for more information on calculations involving Gland Depth.

Groove Depth: The measured depth of a feature, frequently a slot, machined or otherwise created in a mechanical system to physically locate and constrain a seal. Care should be taken to distinguish between the terms Gland Depth and Groove Depth, which are separate but related concepts.

Hardness: A measurement of the resistance to penetration of a rubber or TPE sample by an indenter. High values indicate harder materials while low values indicate softer materials. (See also *Durometer*, *IRHD*, and *Shore A*.)

Heat Deflection Temperature: The temperature at which a standard plastic test bar deflects 0.010 in. (.254mm) under a stated load of either 66 or 264 psi (4.55 or 18.2 Bar).

Honing: A machining process that sharpens, enlarges, and smoothes material through the use of a fine-grit stone.

Hot Manifold: A mold construction that directs the melted plastic internally within the mold base directly to the cavity thus reducing or eliminating the runner. Also known as "Runnerless molding."

Hot Runner: A mold design that maintains the raw material in a molten state up to or very near the mold cavity.

I.D. (Inner Diameter): The innermost (smallest diameter) surface of a circular object, such as a bore or a round seal. The term I.D. is frequently used to indicate both the circumferential surface itself as well as the measured diameter of that surface.

I.R.H.D. (International Rubber Hardness Degrees): A system of characterizing an elastomer by its resistance to penetration of a known geometry indenter by a known force. The microtechnique is reproducible on irregular as well as flat surfaces and on cross sections as small as 1mm in thickness (.04"). Measurements taken using the IRHD scale are similar, but not identical, to those obtained using the Shore A scale.

Injection Molding: A molding method in which a rubber or plastic material is heated and forced under pressure into the mold cavity.

Insert: A term referring to a metal or plastic component, placed ("inserted") into a mold cavity prior to the start of the molding cycle, to which rubber or plastic is chemically and/or physically bonded during the molding process.

Internally Lubricated Rubber: A rubber formulation containing lubricating materials. An internally lubricated rubber is designed to slowly release the lubricant to the surface of the molded part over time.

Joule Effect: A phenomenon characteristic of rubber where rubber which is in tension, when heated, contracts rather than expanding. This effect only occurs when rubber is subject to strain while being heated - unstrained rubber will expand as it is heated (like most materials). This effect has serious consequences for the design of a high speed, rotary shaft seal using a Quad-Ring® (or o-ring). In order to function correctly, in a free state the seal inside diameter must be larger than the outside diameter of the shaft. The seal groove is then designed such that when the Quad-Ring® is placed in the groove, it is compressed onto the shaft. This prevents the frictional heat and the resulting contraction of the seal due to the Joule effect from initiating a cycle (frictional heat causes contraction, causing more friction, generating more heat, leading to more contraction, etc.) causing rapid seal failure.

Knit Mark: A witness mark on a molded part, often occurring at the midpoint between two transfer or injection sprue locations. It is caused by the incomplete joining of the uncured rubber or plastic from each sprue during the molding process.

Knock outs: Normally pins or blades that, when activated internally to the mold, eject the part from the mold. (Also called "ejector pins.")

Land: A feature of an insert, normally flat, that is pinched against a corresponding mold surface to restrict the flow of rubber and thereby control which surfaces of the insert are covered with rubber and which are not. Occasionally termed a "seal-off."

Mechanical bond: A method of creating a molded part where the rubber is mechanically attached to an overmolded insert through the use of holes, depressions or projections on the insert.

Microhardness: A measurement of rubber hardness for specimens below .25 inches (6.35mm) in thickness. Microhardness, like Shore A durometer, is also a measurement of indentation.

Modulus: A measure of the resistance of a material to deformation. It is measured by the force required to reach a predetermined compression or extension.

Necking: An informal (slang) term for seal cross-sectional reduction.

Non-fill: An unintentional void or absence of material in the rubber structure of a part.

O.D. (Outer Diameter): The outermost (largest diameter) surface of a circular object, such as a shaft or a round seal. The term O.D. is frequently used to indicate both the circumferential surface itself as well as the measured diameter of that surface.

Outgassing: The release of volatile chemical components in the form of a gas from an elastomer when it is placed in a vacuum. These volatile components can have the potential to cause undesirable effects, such as fogging optical system components, interfering with the proper functioning of sensitive electronic circuitry or micromechanical systems, or causing corrosion on components. Certain elastomer formulations are more susceptible to outgassing than others, depending on their ingredients.

Overflow Groove: A groove around the periphery of a mold cavity used to accept any excess material from the cavity during molding. Additional material beyond that which is required to fill the cavity is usually introduced into the cavity to ensure that the part is completely formed and to minimize the presence of entrapped air and voids.

Parting Line: The witness line on the surface of a molded part corresponding to the location where the mold plates were in contact.

Permeation: The diffusion of a medium (generally a gas) through a rubber or plastic material.

Piston Seal: A bore seal in which the seal is mounted in a groove machined into a piston. The term piston seal usually implies an application involving linear reciprocating motion.

Plunger: The ram which applies pressure in the process of injection or transfer molding, forcing the material into the mold cavities. Also called an "injection ram."

Post-curing: The process of baking or autoclaving parts after molding. This process is used to improve the heat and compression set resistance of certain specific elastomers.

Pot: The chamber in a transfer or injection mold where raw material is placed before it is transferred into the cavity.

Primary Sealing Interface: *See Primary Sealing Surface*

Primary Sealing Surface: The primary location in a sealing system where a seal and a mating surface come in contact with the intention of forming a barrier to prevent the passage of some type of medium, such as a fluid or a gas. The Primary Sealing Surface is usually distinguished from other sealing surfaces by the presence of relative motion in the case of a dynamic seal, or by the interface of assembled components in the case of a static seal. This term is often used interchangeably with the more generic term Sealing Surface

Radial: Directed along a radius. With a seal ring, the radial direction is in the plane of the seal, and would be parallel to the desktop were the seal ring to be placed flat upon a desktop. The radial direction is perpendicular to the seal axis.

Reciprocating Seal: A seal used in a linear motion application which experiences a repeated reversal of direction of travel.

Regrind: The re-use of material which has previously been processed in a molding operation.

Reinforcing Agent: An ingredient added to a rubber formulation which enhances the materials mechanical properties. Carbon black is a common reinforcing agent used in rubber.

Resilience: The ability of an elastomer to return to original size and shape after deforming forces are removed.

Rod: *See Shaft*

Rod Seal: A sealing system, usually in a radial orientation, in which the primary sealing surface is between the I.D. of a seal ring and the O.D. of a shaft.

Rotary seal: A seal such as an O-ring or a Quad-Ring® seal, exposed on either the I.D. or O.D. sealing surface to a rotating component (e.g. shaft seals). Minnesota Rubber defines a rotating seal as a "rotary" seal if the rotational surface speed is greater than 20 feet/min.

Runner: The system of passages in an injection mold which carries rubber or plastic materials to the cavity gate.

Seal Groove: A feature, frequently a slot, machined or otherwise created in a mechanical system to physically locate and constrain a seal. Care should be taken to distinguish between the terms Gland and Groove, which are separate but related concepts.

Sealing Interface: *See Sealing Surface*

Sealing Surface: Any location where a seal and a mating surface come in contact with the intention of forming a barrier to prevent the passage of some type of medium, such as a fluid or a gas. This term is often used interchangeably with the more specific term Primary Sealing Surface.

Sealing System: The components and attributes which compose the sealing environment, including the seal, the components being sealed, the medium or media being sealed, and the environmental conditions such as temperature, pressure, and motion.

Seal-off: *See Land*

Shaft: A load-bearing and/or power-transmitting member of a mechanical system which is generally cylindrical in shape and frequently rotates or reciprocates.

Glossary-continued

Shore A: A hardness scale used to measure the hardness of molded rubber and TPE's. The Shore A scale is most effectively used to measure rubber with a hardness from 10 to 95 Shore A. For materials harder than 90 to 95 Shore A, the Shore D scale is recommended. (*See also Durometer*)

Shore M: A durometer hardness instrument using a microindicator, designed for the purpose of measuring o-ring hardness.

Short shot: A condition where there is insufficient material introduced into a mold cavity to completely fill the cavity, resulting in a partially formed part.

Shrinkage: The linear contraction upon cooling of a molded rubber or thermoplastic part.

Sliding Core: A component in a mold that automatically retracts when the mold opens.

Specific Gravity: The ratio of the mass of a unit volume of a material to that of the same volume of water at a specified temperature.

Sphericity: Term formerly used to denote Circularity

Spiral Twist: A type of seal failure in reciprocating applications that results from a twisting action that strains or ruptures the rubber.

Sprue: The primary feed channel that runs from the outer face of an injection or transfer mold to the mold gate in a single cavity mold or to runners in a multiple-cavity mold.

Sprue Mark: A small raised spot or depression left on the surface of an injection or transfer molded part. The sprues are the locations at which the elastomer enters into the mold cavity. Also called "gate mark."

Squeeze: An informal (slang) term for the deformation placed on a rubber part to affect a seal. Although it is usually expressed as a percentage of a seal's original (undeformed) cross-section, it is also occasionally expressed as an absolute value of the deformation. (*See also Cross-sectional Compression, Percent*)

Static Seal: A seal that, except for pulsations caused by cycle pressure, does not move in its environment.

Statistical Process Control (SPC): The use of statistical techniques on processes and their output to establish process stability and increase capabilities.

Strain: The deformation caused by an applied stress.

Stress: Force per original cross section that is applied to a specimen.

Stress Relaxation: Decreasing stress with constant strain over a given time interval (viscoelastic response).

Surface Finish: A term usually used in reference to the roughness parameter of a surface's texture, generally expressed in units of microinches (μin) or micrometers (μm).

Swell: The linear or volumetric change of a material resulting from immersion in a particular liquid for a specified period of time. Swell is a general indicator of the compatibility of a material for use in a particular environment.

Tear Strength: The force required to rupture a sample of stated geometry.

Tensile Strength: The extension force per cross-sectional area required to fracture a material specimen.

Thermoplastic: A material which when thermally processed undergoes a reversible phase change to become plastic and capable of being molded to a desired shape. Upon cooling, the material reverts to its original properties.

Thermoplastic Elastomer (TPE): A material which combines the processing characteristics of a plastic but displays rubber-like properties upon completion of processing.

Thermoset: A material, either an elastomer or plastic, which when thermally processed undergoes an irreversible chemical reaction to achieve its final material state.

Total Indicator Reading (TIR): A term used to indicate how the measurement of the roundness of a part, as rotated about its center-line, should be interpreted.

Transfer Molding: A method of molding in which material is placed in a pot located between the top plate and plunger and squeezed from the pot through sprues into the mold cavity.

Ultimate Elongation: Expressed as a percentage of its original length, a measure of how far a material will stretch before breaking.

Undercut: A feature on a part which has a corresponding feature in the part's mold which is perpendicular to the direction of mold movement. An undercut complicates the manufacture of a molded part by making it difficult to remove the finished part from the mold.

Viscosity: The measurement of the resistance of a material to flow under stress.

Volume Change: The measure of the swell or shrinkage of a material resulting from immersion in a particular media (usually a liquid) for a specified period of time at a specified temperature.

Vulcanization: The thermally initiated, irreversible process whereby polymer chains are cross-linked to form the final physical and chemical state of a rubber.

Weathering: The detrimental effect upon an elastomer or plastic after outdoor exposure.