A POLYMER IN MOTION™

Pebax® elastomers
What are Pebax® elastomers?
Pebax® elastomers are block copolymers that offer the best combination of performance (mechanical, chemical, processing) among thermoplastic elastomers (TPE).

A WINNING COMBINATION
- Versatile processing
- The lightest TPE’s
- Wide range of flexibility
- Outstanding physical and chemical properties

The name Pebax® is derived from its own chemistry, polyether block amide. These elastomers are plasticizer free and are available in a wide range of hardness values.

Pebax® resins can be reinforced with various fillers like glass and carbon fiber.

Pebax® resins can also be used pure, as additives, or in blends with other polymers or rubbers.

Optionally bio-based – Select grades marketed under the Pebax® Rnew® brand are partially bio-based.

Pebax® elastomers Bring:
PHYSICAL PROPERTIES
- Lightweight
  - Typically 20% lighter than traditional polymers
  - Low density enables weight reduction without compromise
- Energy return
  - Extremely low energy loss compared to TPU
  - High energy transfer and minimal heat build-up
- Mechanical strength
  - High impact resistance
  - Fatigue resistance
  - Enduring elasticity
  - Good dimensional stability
- Consistent performance at low temperature
  - Maintains impact strength, energy return, and flexibility
  - Soft touch/Good haptics
  - Electrical conductivity (select grades)
  - Bring instantaneous and permanent antistatic properties to other thermoplastic matrices
- Selective molecule diffusion (select grades)
  - Allow a controlled release of active molecules over time (e.g. perfumes, insecticide)
  - Non-porous breathable membranes offer adjustable permeation to water vapor and gas

CHEMICAL PROPERTIES:
Pebax® elastomers provide good chemical resistance for industrial and recreational applications

REGULATORY COMPLIANCES:
Select Pebax® grades comply with USP Class VI and FDA/ECC regulations

VERSATILE PROCESSING:
- Compatible with standard equipment with simple settings
  - Injection, overmolding, extrusion, rotomolding, foaming, fiber and melt spinning, more...
  - Good adhesion when overmolded
  - Thermoforming, coloration, welding, and decoration is possible
  - Recyclable

APPLICATIONS
| SPORTS                  | Extreme lightweight performance and outstanding energy return for sports equipment including footwear components, outsoles, ski boots, and more |
| MEDICAL                | Specific grades with USP Class VI compliance provide flexibility, good touch and feel, excellent processing, breathable features, kink resistance, and sterilization resistance for medical device applications |
| INDUSTRIAL APPLICATIONS | Long-life durability, cold impact performance, chemical resistance, puncture resistance (film), and unique touch and feel benefits industrial applications such as belting and gears |
| FIBER AND NON-WOVEN    | Elastic stretch, chemical resistance, and good processability for fibers and non-woven fabrics |
| PERMANENT ANTISTATIC ADDITIVE | Certain grades intrinsically disperse electrostatic charges and can be added to wide variety of thermoplastic matrices to impart immediate permanent antistatic properties regardless of the relative humidity |
| BREATHABLE MEMBRANES   | Hydrophilic breathable grades offer a wide range of permeation levels according to specific medical requirements |
# Product Range Overview

## Standard Grades
7233, 7033, 6333, 5533, 4533, 4033, 3533, 2533

## Breathable Grades
MV 1041, MV 1074, MV 3000, MH 1657

## Antistatic Grades
MV Grades: 1657, 2030
MH Grades: 1074, 2080

## Stabilization
SA Grades: no additives
SP Grades: UV stabilized

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### General Characteristics

<table>
<thead>
<tr>
<th>CHARACTERISTICS</th>
<th>CONDITIONS</th>
<th>STANDARD</th>
<th>UNITS</th>
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### Rubber Materials Tests

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<td>%</td>
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### Plastic Materials Tests

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<td>DURABILITY – STRESS AT BREAK</td>
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### Bio-Based Grades
Rnew® Grades: 35R53, 40R53, 55R53, 63R53, 70R53, 72R53, 80R53

### Breathable Grades
MV Grades: MV 1041, MV 1074, MV 3000, MH 1657

### Antistatic Grades
MV Grades: 1657, 2030
MH Grades: 1074, 2080

### Stabilization
SA Grades: no additives
SP Grades: UV stabilized
Select Pebax® MED grades are used in medical applications like catheters, PVC-free tubing and medical gowns.

- Most balanced PEBA range
  - The Pebax® MED range has a wide variety of rigid, semi-rigid, and flexible grades for medical applications. Pebax® MED grades have undergone testing in accordance with certain portions of the USP class VI and/or ISO 10993 standards. Contact us for more details.
  - See Arkema’s medical device policy at [arkema.medPolicy](http://arkema.medPolicy)

**APPLICATIONS**
- Catheter
- PVC-free tubing
- Films
- Monofilament

**KEY BENEFITS**
- Softness and flexibility
- Elastic/shape memory
- Kinking resistance
- Torque transfer
- Low coefficient of friction
- Resistance to pressure
- Can be compounded with radiopaque fillers
- Can be used in co-extrusion with TPU
- Breathable and antistatic properties (MV 1074 SA 01 MED)
- Good compromise between strength and softness
- Relatively consistent modulus vs. temperature
- Sterilization feasibility
- Bondable by adhesives or RF welding

**SOLUTIONS**

**PEBAX® MED Range**

<table>
<thead>
<tr>
<th>GRADES</th>
<th>DENSITY (G/CM³) ISO 1183</th>
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**PROPERTY DETAILS**

- Surface Resistivity (Ohm/sq) ISO 60093
- Volume Resistivity (Ohm/cm) ISO 60093
- Refractive Index

*Main Applications: Permanent antistatic additive/Breathable membranes*
Industrial grade Pebax® elastomers exhibit enduring elasticity, fatigue resistance, and cold temperature performance among other benefits. Some common industrial applications include films, belting, silent gears, wires, and cables.

**ADVANTAGES OF USING PEBAX® ELASTOMERS**

The PolyEther Block Amide (PEBA) structure of Pebax® elastomers include a rigid polyamide block and soft polyether block that enable outstanding dynamic properties like flexural fatigue resistance and high energy return (low hysteresis). Even at low temperatures, Pebax® resins maintain flexibility and energy return while also maintaining strong mechanical properties like impact strength, making these resins an excellent choice for applications requiring durability after cyclic motions at varying temperatures.

**KEY BENEFITS**

- Lightweight
- High energy return (low hysteresis)
- Maintains high performance at very cold temperatures
- Flex fatigue resistance
- Low vibration and noise
- Dimensional stability
- Wear resistance
- Easy processing

**FOCUS: ENERGY RETURN**

Generally, energy is lost during a cyclic mechanical stress of a material. This energy loss is a function of the material’s modulus and what we call its energy loss factor (ELF). The microstructure of Pebax® resins contributes to its very low ELF when compared to other thermoplastic elastomers like TPU, as shown in the graphs below.

**FOCUS: CONSISTENT PERFORMANCE AT LOW TEMPERATURE**

Thanks to the low glass transition temperature of its polyether phase, the energy loss factor of Pebax® resins remain low even in sub-zero environments. This allows Pebax® elastomers to maintain flexibility and display almost no increase of elastic modulus compared to other materials at sub-zero temperatures that experience cold stiffening.

For industrial belts and silent gears the lower hysteresis (higher energy return) of Pebax® resins can translate into higher speed and frequencies of use and even subsequent energy savings through better power transmission and low heat buildup.
Elastomers for Sports Equipment

EXTREME PERFORMANCE SOLUTIONS FOR EXTREME ATHLETES

Pebax® elastomers have a wide range of flexibilities, from rigid polyamide-like to soft rubber-like grades. This allows Pebax® resins to be utilized in a wide variety of applications like running shoes, ski boots, and protective gear.

KEY BENEFITS

- Lightweight
- High energy return
- Flex fatigue resistance
- Cold temperature performance
- Shock/Impact resistance
- Easy processing and overmolding

APPLICATIONS

- Athletic shoes and cleats
- Golf balls and putter face
- Ski boots, skis, other winter sports equipment
- Bicycle parts
- Protective gear (e.g. helmet, shin guards)
- Wearable devices

SOFT AND FLEXIBLE TO HARD AND RIGID

Maximum strength where you need support, flexibility where you need movement. Pebax® grades can also be combined within a single component to provide stiffness at one end and flexibility at the other.

WINTER SPORTS – LOW TEMPERATURE PERFORMANCE

Unlike fingers and toes, Pebax® resins do not stiffen in cold weather. Applications like ski boots designed with Pebax® elastomers retain their mechanical properties (strength and impact resistance) and resilience in frigid conditions (-40°C). The Ross Flex machine proves it too: all Pebax® grades can withstand more than 280,000 cycles down to -20ºC and some grades more than 50,000 cycles at -40ºC.

LIGHTEST MATERIALS THAT PACK A PUNCH

Pebax® resins have a very low density that enables the design of lighter parts. This benefit is ideal for outsoles, offering resilience to repeated stress, along with resistance to distortion and deformation. Using Pebax® resin can reduce the plastic component weight by 20%, and even more with Pebax® Foam.

Many sports applications like cleated footwear demand materials with very high strength and increased rigidity. Glass Fiber and Carbon Fiber filled grades are available to improve strength, rigidity, and in the case of Carbon Fiber, maintain lightness.

EXCEPTIONAL ENERGY RETURN

Pebax® resins have the lowest energy loss factor of all thermoplastic elastomers, with the best energy return and an unbeatable flex fatigue resistance. In fact, the shoes worn by all medalists in the marathon event in Rio De Janeiro contained Pebax® elastomers.

<table>
<thead>
<tr>
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<td>Carbon Fiber</td>
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<table>
<thead>
<tr>
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<td>TPU 64 Shore D</td>
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<td>Pebax® Rnew® 63R53</td>
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SOLVING STATIC CHARGE PROBLEMS WITH ANTISTATIC PEBAX® RESINS

Very fast charge decay can damage sensitive electronic components while very slow charge decay can create dust attraction forces and uncontrolled Electrostatic Discharge (ESD events). Select Pebax® grades may be used as permanent (non-fugitive) antistatic additives, producing an excellent compromise.

KEY BENEFITS

As an additive, Pebax® resins can impart permanent antistatic properties in polymer matrices. The antistatic properties are effective immediately and can withstand a broad range of environmental conditions.

- Immediate and permanent antistatic
- Humidity independent
- Maintain colorability of the matrix
- Maintain the physical properties of the matrix
- No sloughing, offgassing or blooming

APPLICATIONS

- Electronics packaging and components
- Storage containers
- Copy machines, printers
- Clean-room and anti-dust applications
- Fibers

RANGE OVERVIEW AND COMPATIBLE MATRICES

Pebax® antistatic additives are delivered in pellet form and can be added to a wide range of polymer matrices either by dry blending or compounding. A compatibilizer may be required depending on the host matrix.

PERMANENT ANTISTATIC ADDITIVES (PEBAX® RESIN) VS TEMPORARY CHEMICAL ANTISTATIC AGENTS

The graphs illustrated below show the evolution of surface resistivity in ABS matrix with Pebax® polymer additives compared to chemical antistatic agents. The addition of Pebax® resin results in immediate and permanent antistatic properties nearly independent of atmospheric relative humidity.
Breathable Films

Breathable, Waterproof Films
When extruded into a thin film or laminated onto a substrate, select hydrophilic Pebax® grades offer excellent permeability to moisture vapor while remaining waterproof and creating an excellent barrier layer to molds and mildews. These Pebax® resins can be laminated onto synthetic nonwovens, wovens, or textiles with the help of functional polyolefins, and may not require any additional adhesives or bonding agents to adhere to these substrates.

Key Benefits
Through their unique copolymer structure, hydrophilic Pebax® grades offer a combination of mechanical strength, breathability, and ease of processing. Unlike microporous products, the monolithic structure of these Pebax® films are a barrier to water and bacteria and exhibit a high level of MVTR (Moisture Vapor Transmission Rate). Each of these advantages make breathable Pebax® resins the material of choice in many applications such as construction house-wrap films, breathable textiles for sports, packaging, and selective membranes.

- Waterproof barrier
- Breathability
- High and adjustable MVTR
- Lightweight
- Excellent toughness and tear resistance
- Flexibility

Processing Breathable Grades
Breathable Pebax® grades can be extruded into a very thin monolithic film (down to 1.5 microns) or laminated onto a wide variety of substrates (e.g. wovens, nonwovens, textiles) offering excellent adhesion for structural integrity. These grades can also be used with compatibilizing resins (functional polyolefins) to adjust their breathability to different levels suitable for a wide range of applications and environments. This design flexibility allows laminators and builders to design a wide range of breathable products.

Application Focus: Monolithic Housewrap
High MVTR allows monolithic housewrap to breathe easily so the moisture vapor behind it does not turn into condensation that potentially leads to mold and mildew in the walls. The water resistance of hydrophilic Pebax® grades enable the housewrap to protect the housing structures from water-related failures. Tear resistance is also key as during installation, housewrap is prone to tearing damages at the jobsite. A very durable and tear resistant film can make it easier for the construction workers to wrap the house more efficiently and safely.

Breathability – MVTR Data
Breathability can be described as the Moisture Vapor Transmission Rate (MVTR) and it represents the amount of water vapor that passes through a film or structure over a period of 24 hours. It is measured per ASTM E96 A/B/BW/E methods in g/m²/day at 50% or 90% RH and at 23°C or 38°C. Depicted in the graphs below, select Pebax® grades offer high levels of MVTR under different conditions.

General Characteristics: Breathable Grades

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<th>STANDARD</th>
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<td>Water Absorption at Equilibrium</td>
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<td>23°C, 50% RH, 15µm Film</td>
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<td>g/m²·h</td>
<td>245</td>
<td>570</td>
<td>530</td>
<td>320</td>
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Rain
Pebax® Film
Fabric/Textile
Liner
Sweat
MVTR ASTM METHOD E96A
@50% RH, 23°C

MVTR ASTM METHOD E96B
@50% RH, 23°C
SELECTION DIFFUSION
A common challenge in the active molecule and fragrance carrier industry is uniform distribution of fragrance and controlling the rate of release of the scent. The block amide-ether structure of Pebax® polymers can enable the absorption and controlled release of volatile molecules like fragrances, oils, and even insecticides at just the right rate over extended periods of time.

APPLICATIONS
• Air fresheners
• Aroma candles
• Fire-less candles
• Toilet cleaners
• Dishwasher tables
• Scented/Flavored dental floss
• Insect repellants
  - Wearable, non-wearable, livestock tags, pet collars

KEY BENEFITS
• Selective absorption
  - Polyether phase accepts many volatile molecules
  - Good absorption up to 50%
• Controlled release
  - Manipulate diffusion with wall thickness and temperature
  - Very good retention of fragrance properties
• Strong mechanical structure
  - Preserved by the polyamide block
  - Maintain the integrity of the finished part
• Low melting point
  - Molding and extrusion without degrading the fragrance substances
• Easy processing
  - Save time and money with more efficient processing

FOCUS – ABSORPTION AND DIFFUSION PROPERTIES
While materials like cellulose might absorb much more fragrance than Pebax® polymers at first, the scent is quickly diffused leaving the consumer with a potent wakeup call in the first days, but also the responsibility to replace their air freshener much more frequently. Pebax® 2533 SA01 exhibits a controlled release curve, providing a much better user experience.

FOCUS – CONSISTENT SUBSTANCE RELEASE
Using chromatography methods, the evolution of a particular fragrance can be measured (answering the question, does the fragrance smell the same as it did 50 days ago?). The graph below illustrates how a cellulose carrier can affect the olfactory notes of perfumes like lavender. Contrary to a cellulose support, Pebax® 2533 SA01 allows for a consistent diffusion at a consistent rate, while maintaining the integrity of the scent.

REFERENCE PEBA® 2533 SA01 CELLULOSE EVA 28%

| % LAVENDER ABSORPTION | 50 | 70 | 30 |
| % LAVENDER AFTER 60 DAYS | 11 | 3 | 2 |

FOCUS – PROCESSABILITY
Pebax® 2533 SA01 pellets can be impregnated before melt processing through dry-blending with the volatile substances. The low melting point (134°C) allows for injection molding and extrusion of the polymer without degradation of volatile substances. Standard conditions of processing and coloration may also be used, although lower processing temperatures are recommended to avoid modification of the volatile substances.
Pebax® resins have excellent processability in each of the major thermoplastic processing technologies:

- Injection molding
- Extrusion (e.g. cast film, blown film, sheet, tube)
- Assembly process: overmolding and coextrusion

**HANDLING AND STORAGE RECOMMENDATIONS**

- For unopened bags, resins are ready-to-use without redrying.
- Storage temperature should be less than 40 - 50ºC and avoid high humidity.
- Heated hoppers are not necessary when processing Pebax® resin.
- To avoid condensation, store bags in the workshop 24 hours prior to processing.
- Avoid using pellets from bags that have been open for longer than 2 hours.
- During trials, manually close the bags after feeding the hopper to avoid moisture uptake.
- After a one-day trial, reseal the bag before re-using the next day.
- Shelf life is 2 years from the date of delivery in properly sealed and stored conditions.

**DRYING CONDITIONS**

Pellets exposed to atmospheric conditions for more than 2 hours should be dried before processing (see table below). Place the granules onto a clean flat metallic tray for efficient drying. Arkema highly recommends using vacuum drying because the absence of oxygen allows for higher temperatures, which saves time. Desiccant dryers are also efficient with regularly changed filters.

**INJECTION MOLDING**

The rheological behavior of Pebax® resins allows for:
- A wide range of processing temperatures compared to other thermoplastic elastomers (especially TPUs).
- Ability to inject extremely thin parts (down to 0.8 mm).
- Short cycle times.
- High recyclability.
- Accurate dimension control.

**RECOMMENDATIONS**

- Residence time: < 10 min.
- Injection volume: 25 - 80% of total shot capacity.
- Compression ratio: 2.2 - 2.8.
- Correct check valve.
- Shrinkage rate: 0.5 - 1.5%.
- Varies depending on the grade selected and on the injection conditions.

**MOLDING CONDITIONS**

### Melt Temperature (°C)

<table>
<thead>
<tr>
<th>GRADES</th>
<th>7233</th>
<th>7303</th>
<th>6333</th>
<th>5333</th>
<th>4033</th>
<th>3533</th>
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<tr>
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<td>250</td>
</tr>
</tbody>
</table>

### Mold Temperature (°C)

<table>
<thead>
<tr>
<th>GRADES</th>
<th>Filled Grades</th>
<th>S500 Grades (5533 → 7233)</th>
<th>S500 Grades (2533 → 4033)</th>
</tr>
</thead>
<tbody>
<tr>
<td>RECOMMENDED</td>
<td>40 - 60</td>
<td>25 - 60</td>
<td>10 - 30</td>
</tr>
</tbody>
</table>

**INJECTION MOLDING COMPARABILITY**

With an extensive flexibility and hardness range, Pebax® polymers are suitable for a variety of applications. It is possible however, to mix various grades of Pebax® in order to achieve specific properties. Arkema technical experts will be pleased to assist you in selecting the Pebax® blend that will meet your specification criteria.

**OVERMOLDING**

Insert molding offers a countless combination of possibilities with a variety of materials such as glass, metals, polymers, and textiles. The overmolding technique is widely used to manufacture soles at athletic footwear like football cleats. Pebax® resins possess a wide plasticizing range, which makes them highly suitable for overmolding. The adhesion of Pebax® elastomers onto inserts can be optimized by adjusting the processing parameters. See the general overmolding materials on the next page and contact Arkema to further discuss your overmolding questions.

**DRYING HEAT AND TIME REQUIREMENTS**

- **Hard grades:**
  - **Temperature:** 70 - 80°C
  - **Air flow:** 4 - 6
  - **Time:** 4 - 6 hours
- **Soft grades:**
  - **Temperature:** 65 - 75°C
  - **Air flow:** 5 - 7
  - **Time:** 6 - 8 hours
- **Serious issues:**
  - **Temperature:** 65 - 65°C
  - **Air flow:** 6 - 6 hours

**OVERMOLDING**

- **Sheets**
- **Tubes**

Pebax® resins can be extruded on conventional equipment. Arkema personnel will be pleased to provide specific processing parameters related to Pebax® resins in technologies such as tube drawing, blown film drawing, or the cooling conditions for sheet calendaring.

**COLORATION**

- **Masterbatches**
  - Polyamide-based masterbatches are recommended (instead of polylefin) with a similar viscosity to Rilsan® or Pebax® resins.
  - Compounding is always better, sometimes necessary.
- **pigment blends**
  - Recommended: preliminary compounding with material to be colored.
  - Careful choice of pigments (to avoid migration phenomena or processing issues due to presence of organic colorants).
  - Liquid colorants.
  - Solvent as a lubricant so the flow of material is affected.

**WELDING**

There are many techniques suitable for welding Pebax® resin:
- Ultrasonic welding technique: for soft grades only (2533, 3533).
- Induction technique.
- High frequency technique (due to polarity).
- Mirror technique.
- Radio frequency welding.

**DECORATION**

Choosing a technique to use depends on application, geometry of part, and cost. Many techniques are suitable for decorating Pebax® resin:
- Laser printing.
- Hot stamping.
- Ink printing.
- Clear coat/laquer.
- Inmold decoration techniques (e.g. carmoling, insertmolding, inmold labeling).

**THERMOFORMING AND SUBLIMATION**

This technology has been primarily developed to meet requirements for ski applications and can be applied in other fields with minor changes. After decoration, Pebax® film can be thermoformed and stamped to meet the required shape and size. This produces an insert that can be overmolded by Pebax® resin for example, or it produces a film that can be thermobonded on a substrate, such as composites.

**VACUUM OVEN**

- **Temperature:** 70 - 240°C
- **Duration:** 2 - 6 hours