Pebax®

High Performance Permanent Antistatic Agent
Outline

- What is Pebax®?
- Pebax® Antistatic properties
- Standard Antistatic Pebax® Grades
- Lower Resistivity Pebax® Grades
- Processing
- Market & Applications
What is Pebax®?

- **Two phases structure**
  - **Polyamide**: clear melting point (133°C at 172°C)
  - **Polyether**: very low glass transition temperature (-60°C) providing exceptional properties at low temperatures

- **Thermoplastic elastomer (TPE)**
- **Poly Ether Block Amide (eXtreme)**

\[
\text{HOOC} - \text{PA} - \text{COOH} + \text{HO} - \text{PE} - \text{OH} \\
\text{Dicarboxylic Polyamide} \quad \text{Polyether diol}
\]

PolyEther Block Amide (PEBA)

Pebax® as antistatic additive
Pebax® Antistatic Grades

Grades & Performance Range:

<table>
<thead>
<tr>
<th>Surface Resistivity (Ohms/sq)</th>
<th>Conductive</th>
<th>Static Dissipative</th>
<th>Antistatic</th>
<th>Insulator</th>
</tr>
</thead>
</table>

- **Very fast charge decay** → Can damage sensitive electronic parts
- **Very slow charge decay** → Charges create risk of electric shock and dirt attracting forces

<table>
<thead>
<tr>
<th>Pebax® MV2080</th>
<th>Pebax® MH2030</th>
<th>Pebax® MV1074</th>
<th>Pebax® MH1657</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Surface Resistivity (Ohms/sq)</strong></td>
<td><strong>1 x 10^7</strong></td>
<td><strong>1 x 10^7</strong></td>
<td><strong>3 x 10^9</strong></td>
</tr>
</tbody>
</table>

- Pebax® Prevent Static Electricity build-up, uncontrolled discharge as well as dust attraction.
- Pebax® can be used in: PA, ABS, ABS/PC, HIPS, PET, POM, PVC, PE, PP, …
Non Permanent Chemical Antistat

Mode of Action:
- Low molecular weight chemical species with a non-polar chain and a polar hydrophilic head
- Migrate to the surface of the material, attracts water which lowers RS and allows to dissipate static charges:

**BUT:**
- Need ambient humidity to be efficient: **No effect in dry conditions.**
- Need time to migrate and bring antistatic properties: **No immediate effect.**
- With time additives are wiped away from the surface of the material: **No Permanent effect,** Static charges will reappear.

**Mode of action**

1. **Phase 1**
   - Dilution of the Chemical antistat additives in the matrix during process

2. **Phase 2**
   - Additives starts to migrate to the material's surface after processing

3. **Phase 3**
   - Chemical Additives cover the surface

4. **Phase 4**
   - Chemical Additives attract water from atmosphere

5. **Phase 5**
   - With time additives are wiped away from the surface of the material. Static charges reappears

6. **Phase 6**
   - Material loses antistatic properties and becomes isolative again.

Pebax® as antistatic additive
**Pebax® Antistatic Properties**

**Principle of Pebax® Permanent Antistatic**

- Addition of Pebax® to the Polymer matrix by dry blend, both polymers are mixed during processing,

Antistatic Pebax® domains forms a **Permanent 3D ionic dissipative network** within the matrix which allows to dissipate charges along Pebax backbone.
Pebax® Antistatic Properties

Pebax® vs Non permanent Chemical Antistats:

- Antistatic Pebax® forms a polymer network in the matrix, it doesn’t migrate nor bring any blooming
- Pebax® antistatic effect is immediate and permanent.

Chemical antistatic agents are very sensitive to relative humidity and are inefficient in dry conditions

Pebax® antistatic effect is maintained even at low humidity level.
# Pebax® Antistatic Properties

## Pebax® vs Non permanent Chemical Antistats:

<table>
<thead>
<tr>
<th>Property</th>
<th>Pebax®</th>
<th>Chemical anti-static agent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Very low humidity influence</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>Immediate antistatic effect</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>Permanent antistatic effect</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>Thermally stable</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>Recyclable</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>No blooming or migration</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>Non-corrosive</td>
<td>Yes</td>
<td>No</td>
</tr>
</tbody>
</table>

Pebax® as antistatic additive
Standard Antistatic Pebax® Grades

Pebax® MH1657 and MV1074, Main Properties:

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>Standard</th>
<th>Units</th>
<th>Pebax® grades</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>MV1074</td>
</tr>
<tr>
<td>Surface resistivity (*)</td>
<td>ASTM D257</td>
<td>Ohm/sq</td>
<td>3 x 10^9</td>
</tr>
<tr>
<td>Volume resistivity (*)</td>
<td>ASTM D257</td>
<td>Ohm.cm</td>
<td>2.5 x 10^9</td>
</tr>
<tr>
<td>Charge decay time</td>
<td>MIL B-81705</td>
<td>sec</td>
<td>&lt; 1</td>
</tr>
<tr>
<td>Density</td>
<td>ISO 1183</td>
<td>g/cm^3</td>
<td>1.07</td>
</tr>
<tr>
<td>Melting point</td>
<td>ISO 11357</td>
<td>degC</td>
<td>158</td>
</tr>
<tr>
<td>Refractive index</td>
<td>ISO 489</td>
<td>-</td>
<td>1.502</td>
</tr>
</tbody>
</table>

(*) measurement done at 23°C, 50%RH)

Regulatory Compliances:

<table>
<thead>
<tr>
<th>Regulatory Compliances</th>
<th>Food Approvals</th>
<th>Medical</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>EU 2002/72</td>
<td>FDA (*)</td>
</tr>
<tr>
<td>MV1074 SA01</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>MH1657</td>
<td>Yes</td>
<td>-</td>
</tr>
</tbody>
</table>

(*) Pebax® MV1074 SA01 may be used in polymers at concentrations up to 15% by weight of the polymer, in contact with non-fatty dry foods, under Conditions of Use E through G, as described in 21 CFR 176.170 (c) Table2. Contact Arkema for details.
Standard Antistatic Pebax® Grades

**MV1074 SA01:** Clean grade for sensitive applications:

- Very low ionic species content.
- Very low monomers / oligomers outgassing.
- Capro lactame free / Bisphenol A free.

- USP Class VI approved for medical applications.
- EU 2002/72 European Food contact approved.
- FDA approved (contact Arkema for details)

**Very low Ionic Species content (μg/cm²):**

- Pebax® MV1074 SA01: 0.673 μg/cm²
- Competitor 1: 1.44 μg/cm²
- Competitor 2: 0.87 μg/cm²

**Br⁻, NO₂⁻, PO₄³⁻, SO₄²⁻, Li⁺** not detected in MV1074 SA01

**Very Low Outgassing:**

- Pebax® MV1074 SA01: Not Detected
- Competitor 1: 3700 ppm
- Competitor 2: 3960 ppm

Analysis performed at SGS lab, Taiwan.
(Detection down to 0.0010 μg/cm².)

MS/GC/FID analysis
(detection down to 80 ppm)
Antistatic Pebax® standard grades can be used in a wide range of matrices:

Typical levels of addition and Performance:

<table>
<thead>
<tr>
<th>Polymer Matrix</th>
<th>Pebax Grade</th>
<th>Typical Pebax Addition Level (wt%)</th>
<th>Compatibilizer (*)</th>
<th>Surface Resitivity (Ohms/sq)</th>
</tr>
</thead>
<tbody>
<tr>
<td>PE</td>
<td>MV1074</td>
<td>15 to 25%</td>
<td>Lotader 3210 (1-3%)</td>
<td>$10^{11}$ to $10^{12}$</td>
</tr>
<tr>
<td>PP</td>
<td>MV1074 or MH1657</td>
<td>15 to 25%</td>
<td>Orevac CA100 (1-3%)</td>
<td>$10^{11}$ to $10^{12}$</td>
</tr>
<tr>
<td>PS or HIPS</td>
<td>MV1074 or MH1657</td>
<td>10 to 20%</td>
<td>Lotader AX8900 (1-2%)</td>
<td>$10^{11}$ to $10^{12}$</td>
</tr>
<tr>
<td>PVC</td>
<td>MV1074</td>
<td>10 to 20%</td>
<td>No</td>
<td>$10^{11}$ to $10^{12}$</td>
</tr>
<tr>
<td>ABS or ABS/PC</td>
<td>MV1074 or MH1657</td>
<td>10 to 20%</td>
<td>No</td>
<td>$10^{10}$ to $10^{12}$</td>
</tr>
<tr>
<td>PMMA</td>
<td>MV1074</td>
<td>10 to 20%</td>
<td>No</td>
<td>$10^{11}$ to $10^{12}$</td>
</tr>
<tr>
<td>PET</td>
<td>MV1074 or MH1657</td>
<td>10 to 20%</td>
<td>No</td>
<td>$10^{11}$ to $10^{12}$</td>
</tr>
<tr>
<td>POM</td>
<td>MV1074 or MH1657</td>
<td>10 to 20%</td>
<td>No</td>
<td>$10^{11}$ to $10^{12}$</td>
</tr>
<tr>
<td>PA</td>
<td>MV1074 or MH1657</td>
<td>10 to 20%</td>
<td>No</td>
<td>$10^{11}$ to $10^{12}$</td>
</tr>
</tbody>
</table>

Addition levels and resistivity values presented in this table are indicative and based on internal experience, they may vary depending on matrix rheology and processing.

(*) Lotader® and Orevac® are Arkema’s Functional polyolefins, consult following website for more details: [www.lotader.com](http://www.lotader.com)  [www.orevac.com](http://www.orevac.com)
Lower Resistivity Pebax® Grades

2 New Antistatic Pebax® grades with Lower Resistivity have been developed:

MH2030 and MV2080

General properties

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>Standard</th>
<th>Pebax® MH2030</th>
<th>Pebax® MV2080</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Density</td>
<td>ISO 1183</td>
<td>1.14</td>
<td>1.07</td>
<td>g/cm³</td>
</tr>
<tr>
<td>Melting point</td>
<td>ISO 11357</td>
<td>200</td>
<td>160</td>
<td>°C</td>
</tr>
<tr>
<td>Surface Resistivity (*)</td>
<td>ASTM D257</td>
<td>10^7</td>
<td>10^7</td>
<td>Ohms/sq</td>
</tr>
<tr>
<td>Volume Resistivity (*)</td>
<td>ASTM D257</td>
<td>10^7</td>
<td>10^7</td>
<td>Ohms.cm</td>
</tr>
<tr>
<td>Refractive Index</td>
<td>Internal method</td>
<td>1.508</td>
<td>1.502</td>
<td>-</td>
</tr>
</tbody>
</table>

(*) Samples conditioned 15 days at 23°C - 50 % R.H

- Both grades are suitable for a wide range of Matrices (ABS, HIPS, PET, PE, PP,....)
- Pebax® MV2080 is particularly recommended for:
  - Polyolefin Film applications (lower melting point).
  - High cleanliness applications requiring low outgassing.
Lower Resistivity Pebax® Grades

Development grades **MH2030 and MV2080:**

Improved Intrinsic Antistatic Performance: $Rs = 1 \times 10^7$ Ohms/sq

- **2 Decades lower** vs standard Antistatic Pebax® grades.

- **Improved Antistatic Performance transferred in Matrices (injected plates).**

**Pebax® MH2030 and MV2080** Allow to reach lower levels of Surface Resistivity in final parts.
**Lower Resistivity Pebax® Grades**

Better Antistatic Performance of MH2030 and MV2080 in ABS (Injection):

- **Competitor:** $R_s = 1 \times 10^9$ Ohms/sq
- **MH2030 and MV2080:** $R_s = 1 \times 10^7$ Ohms/sq

- **MH2030 and MV2080 better antistatic Properties:**

1) Allows to reach Lower $RS$ at same loading

2) Allows to reach same Antistatic properties at Lower concentration.

$\Rightarrow$ Low Impact on Matrix Properties
**Lower Resistivity Pebax® Grades**

**Better Antistatic Performance in PP and HIPS (Injection):**

- **Competitor:** $R_s = 1 \times 10^9$ Ohms/sq
- **MH2030 and MV2080:** $R_s = 1 \times 10^7$ Ohms/sq

- **MH2030 and MV2080 better antistatic Properties:**
  1. Allows to reach **Lower Surface Resistivity** at same concentration.
  2. Allows to reach **same Antistatic properties** at **Lower concentration** $\Rightarrow$ **Low Impact on Matrix Properties**

![Graph showing surface resistivity comparison between Pebax and competitor in PP and HIPS](image-url)
Processing

Pebax®:

- Is delivered under pellets form, ready to be processed.
- Can be processed by injection molding or extrusion.
- Can be added by dry-blending.
- Can be compounded without any special screw profile.
- Typical addition levels are 10 – 20 % depending on host matrix and processing technology.

For an optimum performance:

- Compatibilizer may be added in Polyolefins Matrices:
  - Lotader® 3210 for PE, Orevac® CA100 for PP ( Typical Pebax® / Compatibiliser ratio: 10/1).
- For injection, high injection speed (300cc/s) are recommended.
- For extrusion, high viscosity ratios between Pebax® and Host Matrix are recommended.
Market & Applications

- Bags, Foam
- Thermoformed trays
- Carrier tapes, reel tapes

Antistatic packaging

Industrial

And also...

Electronic products

- Clean room equipment
- Surface and flooring
- Containers, Big Bags for flammable or explosive goods

- Household appliances (hand tools, vacuum cleaner parts...)
- Pebax MV 1074 SA is USP Class VI approved and can be used in medical applications (inhalators, pharma-bags...)

Printers tray
- Mail/paper sorters
- Electronics housing
The Key to High Performance Static-Dissipative Alloys:

- Permanent and Immediate antistatic properties
- Very low influence of relative humidity on antistatic properties
- No blooming or migration out of the matrix
- Can be added directly by dry-blend for injection and extrusion in a wide range of matrices
- Possible coloration of final product.

Standard grades:
- MV1074 SA01 and MH1657 have food approvals (*)
- MV1074 SA01 has USP Class VI approval for medical applications

(*) See corresponding slide or Contact Arkema for details.

Lower Resistivity Grades MH2030 and MV2080:
- Maintain antistatic performance at reduced loadings vs competitors:
  => Low impact on matrix properties
- Allow to reach static dissipative properties