Solef® PVDF
for Flexible Battery Separators
Some differences may be highlighted between PVDF homopolymer and copolymers. Homopolymers are soluble in a limited number of solvents such as NMP, DMAc, DMF, TEP and DMSO and they show low swelling ability in electrolytes. Their melting temperature and crystallinity are high, determining superior mechanical properties and high thermal resistance.

Copolymers are soluble in a wider range of solvents including, for instance, acetone, MEK and THF for easier processing. They have high swelling ability which allows the design of gel polymer membranes or coating adhesive layers.

**Swelling Properties**
The high compatibility of PVDF with electrolytes guarantees fast wettability and suitable ionic conductivity. Due to the different crystallinity, PVDF homopolymers can uptake lower amounts of electrolytes and maintain the original shape, while copolymers can reach high swelling levels especially at high temperatures.

For a comparison among various PVDF homopolymer and copolymer grades, swelling experiments have been performed on molded test samples, which have been immersed in a standard mixture of electrolyte (EC/DMC/DEC 2:2:1) and LiPF₆ 1 M for 30 days. Maximum swelling values give an indication of the compatibility of the polymer with a specific electrolyte.

![Swelling Properties Graph](image)

**Advantages of Solef® PVDF Grades**
Due to its physical-chemical properties, PVDF can be processed by different processing methods including solutions-based and melt extrusion technologies. It offers various advantages when it is utilized in the design of separator, as main component or even just as a thin coated layer:

- Electrochemical stability from 0 to 5 V vs Li⁺/Li⁻
- Solubility for easy processing
- Fast wettability of the membrane
- Controlled leakage of electrolytes
- Durable adhesion with electrodes
- Flexibility for lamination process

**Product Range**
According to the specific design of the separator and to the manufacturing process, it is possible to select the most appropriate Solef® PVDF grade.

<table>
<thead>
<tr>
<th>Grade</th>
<th>Type of Polymer</th>
<th>Application</th>
<th>Molecular Weight [kDa]</th>
<th>Melting Temp. [°C]</th>
</tr>
</thead>
<tbody>
<tr>
<td>Solef® 1015</td>
<td>PVDF standard homopolymer</td>
<td>Porous separator for high ionic conductivity</td>
<td>570 – 600</td>
<td>170 – 175</td>
</tr>
<tr>
<td>Solef® 6020</td>
<td></td>
<td></td>
<td>670 – 700</td>
<td>170 – 175</td>
</tr>
<tr>
<td>Solef® 21216</td>
<td>PVDF-HFP copolymer acetone soluble</td>
<td>GEL polymer technology for safety and flexibility or coating of polyolefin separator</td>
<td>570 – 600</td>
<td>130 – 136</td>
</tr>
<tr>
<td>Solef® 21510</td>
<td></td>
<td></td>
<td>290 – 310</td>
<td>130 – 136</td>
</tr>
<tr>
<td>Solef® 31508</td>
<td>PVDF-CTFE copolymers acetone soluble</td>
<td>Coating of polyolefin separator</td>
<td>270 – 290</td>
<td>167 – 171</td>
</tr>
</tbody>
</table>

www.solvay.com

SpecialtyPolymers.EMEA@solvay.com | Europe, Middle East and Africa
SpecialtyPolymers.Americas@solvay.com | Americas
SpecialtyPolymers.Asia@solvay.com | Asia Pacific

Material Safety Data Sheets (MSDS) are available by emailing us or contacting your sales representative. Always consult the appropriate MSDS before using any of our products. Neither Solvay Specialty Polymers nor any of its affiliates makes any warranty, express or implied, including merchantability or fitness for use, or accepts any liability in connection with this product, related information or its use. Some applications of which Solvay’s products may be proposed to be used are regulated or restricted by applicable laws and regulations or by national or international standards and in some cases by Solvay’s recommendation, including applications of food/feed, water treatment, medical, pharmaceuticals, and personal care. Only products designated as part of the Solviva® family of biomaterials may be considered as candidates for use in implantable medical devices. The user alone must finally determine suitability of any information or products for any contemplated use in compliance with applicable law, the manner of use and whether any patents are infringed. The information and the products are for use by technically skilled persons at their own discretion and risk and does not relate to the use of this product in combination with any other substance or any other process. This is not a license under any patent or other proprietary right. All trademarks and registered trademarks are property of the companies that comprise Solvay Group or their respective owners.

© 2013 Solvay Specialty Polymers. All rights reserved.  R 09/2013 | Version 2.1    Brochure design by ahlersheimel.com