

Solef®



**SOLVAY**  
asking more from chemistry®

# Solef® PVDF

## Typical Properties

**SPECIALTY  
POLYMERS**

# Solef® PVDF

## Polyvinylidene Fluoride

Solef® PVDF is a fluorinated semi-crystalline thermoplastic which is obtained by polymerizing vinylidene fluoride. This fluorinated polymer has been manufactured and marketed for more than 30 years, using both suspension and emulsion process developed and perfected by Solvay Specialty Polymers.

Solef® PVDF, without any additives, has the intrinsic stability inherent to fluoropolymers, even when exposed to harsh environments. It provides the user with a unique combination of properties leading to longer equipment life. The most important properties of Solef® PVDF are listed below:

- Excellent chemical resistance to most aggressive substances and solvents
- Excellent mechanical strength and toughness
- High abrasion resistance
- High temperature capabilities: continuous use service temperature up to 150 °C/302 °F
- Excellent ageing resistance
- High purity
- Resistance to UV and nuclear radiations
- Excellent intrinsic fire resistance
- Low permeability to most gases and liquids
- Easily melt-processed by standard methods of extrusion and molding
- Wide range of rigid and flexible grades available

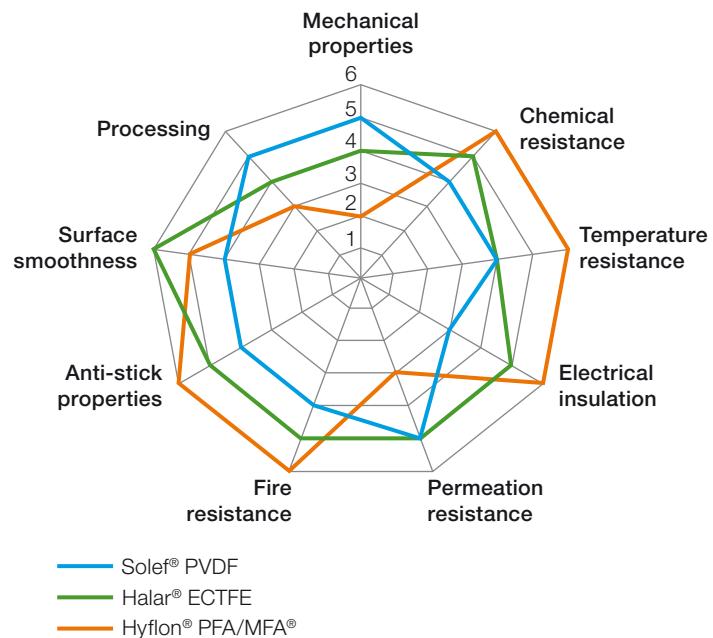
Besides the PVDF homopolymers, Solvay Specialty Polymers offers a wide products range of VF2-HFP copolymers, and VF2-CTFE copolymers which stand out for their better cold temperature behavior. The VF2-CTFE range comprises the Solef® 60000 series, which offers an improved balance between good cold temperature properties and thermomechanical properties of the homopolymers.

PVDF is extensively used in the general chemical processing industry, the high purity semiconductor market, and the wire and cable industry. Solvay Specialty Polymers today offers a growing choice of PVDF grades which are associated with new applications such as the Oil & Gas industry, Automotive, Building industry, Electronics, Chimney linings, Lithium Batteries, Fuel cells, Food and Pharmaceutical industries.

In addition to the Solef® resins, Solvay Specialty Polymers offers a wide range of other fluoropolymers which are also easily processable by injection, extrusion, and all conventional processing techniques:

- Halar® ECTFE (copolymer of ethylene and chlorotrifluoroethylene)
- Hyflon® PFA/MFA® (copolymer of tetrafluoroethylene and perfluoroalkylvinylethers)
- Hylar® PVDF for coating applications

## Relative performance of melt processable fluoropolymers



## Solef® PVDF grades

| Grade               | Form                | Description   |
|---------------------|---------------------|---|
| <b>Homopolymers</b> |                     |   |
| <b>Solef® 6008</b>  | Powder and granules | Low molecular weight PVDF homopolymer                       |
| <b>Solef® 6010</b>  | Powder and granules | Medium molecular weight PVDF homopolymer                    |
| <b>Solef® 6012</b>  | Powder and granules | High molecular weight PVDF homopolymer                      |
| <b>Solef® 1015</b>  | Powder              | Very high molecular weight PVDF homopolymer                 |
| <b>Solef® 6020</b>  | Powder              | Ultra high molecular weight PVDF homopolymer                |
| <b>Solef® 5130</b>  | Powder              | Ultra high molecular weight functionalized PVDF homopolymer |
| <b>Solef® 9007</b>  | Powder and granules | Low molecular weight PVDF homopolymer                       |
| <b>Solef® 9009</b>  | Powder and granules | Medium molecular weight PVDF homopolymer                    |
| <b>Solef® 460</b>   | Powder and granules | Branched high molecular weight PVDF homopolymer             |
| <b>Solef® 41308</b> | Powder and granules | Enhanced adhesion PVDF for multilayer structures            |
| <b>Copolymers</b>   |                     |   |
| <b>Solef® 11010</b> | Powder and granules | Flexible PVDF copolymer                                     |
| <b>Solef® 21510</b> | Powder and granules | Very flexible PVDF copolymer                                |
| <b>Solef® 31508</b> | Powder and granules | Improved low-temperature flexibility PVDF copolymer         |
| <b>Solef® 60512</b> | Granules            | Special PVDF grade for high-pressure flexible piping        |

## Typical Properties of Solef® PVDF Homopolymer Grades

| Unit  | Solef® 6008        | Solef® 6010              | Solef® 6012              | Solef® 1015              | Test Method              |
|---|--------------------|--------------------------|--------------------------|--------------------------|--------------------------|
| <b>Physical properties</b>                                  |                    |                          |                          |                          |                          |
| Density at 23 °C/73 °F                                      | g/cm³<br>(lb/ft³)  | 1.75–1.80<br>(110–112)   | 1.75–1.80<br>(110–112)   | 1.75–1.80<br>(110–112)   | 1.75–1.80<br>(110–112)   |
| Water absorption<br>(24 h at 23 °C/73 °F)                   | %                  | < 0.04                   | < 0.04                   | < 0.04                   | < 0.04                   |
| Melt flow index (230 °C/446 °F)                             | g/10 min           |                          |                          |                          | ASTM D1238               |
| 21.6 kg   |                    | –                        | –                        | –                        | 2.8–4.6                  |
| 10 kg   |                    | –                        | –                        | 4–6                      | –                        |
| 5 kg  |                    | 16–30                    | 4–8                      | –                        | –                        |
| 3.8 kg  |                    | –                        | –                        | –                        | –                        |
| 2.16 kg   |                    | 5.5–11                   | –                        | –                        | –                        |
| <b>Mechanical properties</b>                                |                    |                          |                          |                          |                          |
| Tensile at 23 °C/73 °F<br>(Type IV specimen, 2 mm thick)    |                    |                          |                          |                          | ASTM D638                |
| Stress at yield<br>(50 mm/min)                              | MPa<br>(psi)       | 50–60<br>(7,200–8,700)   | 50–60<br>(7,200–8,700)   | 50–60<br>(7,200–8,700)   | 50–60<br>(7,200–8,700)   |
| Stress at break<br>(50 mm/min)                              | MPa<br>(psi)       | 30–50<br>(4,400–7,300)   | 30–50<br>(4,400–7,300)   | 30–50<br>(4,400–7,300)   | 30–50<br>(4,400–7,300)   |
| Elongation at yield<br>(50 mm/min)                          | %                  | 5–10                     | 5–10                     | 5–10                     | 5–10                     |
| Elongation at break<br>(50 mm/min)                          | %                  | 20–300                   | 20–300                   | 20–300                   | 20–300                   |
| Modulus<br>(1 mm/min)                                       | MPa<br>(kpsi)      | 1,800–2,500<br>(260–360) | 1,700–2,500<br>(250–360) | 1,700–2,500<br>(250–360) | 1,700–2,500<br>(250–360) |
| Notched charpy strength<br>(4 mm thick, 2 m/s, 23 °C/73 °F) | J/m<br>(ft·lbf/in) | 40–120<br>(0.7–2.0)      | 100–200<br>(2–4)         | 150–250<br>(3–5)         | 400–500<br>(7.5–10)      |
| IZOD impact (notched V 10 mm,<br>23 °C/73 °F, 4 mm thick)   | J/m<br>(ft·lbf/in) | –                        | –                        | –                        | –                        |
| Shore D hardness (2 mm thick)                               |                    | 73–80                    | 73–80                    | 72–78                    | 72–78                    |
| Abrasion resistance   | mg/1,000<br>rev    | 5–10                     | 5–10                     | 5–10                     | 5–10                     |
| Friction coefficient  | static<br>dynamic  | 0.2–0.4<br>0.15–0.35     | 0.2–0.4<br>0.15–0.35     | 0.2–0.4<br>0.15–0.35     | 0.2–0.4<br>0.15–0.35     |
|   |                    |                          |                          |                          | ASTM D1894               |

| Unit  | Solef® 6008                                   | Solef® 6010          | Solef® 6012                   | Solef® 1015                   | Test Method   |
|---|---|----------------------|-------------------------------|-------------------------------|---|
| <b>Thermal properties</b>   |   |                      |                               |                               |   |
| Crystallinity by DSC  |   |                      |                               |                               | ASTM D3418  |
| Melting point   | °C<br>(°F)                                    | 170–175<br>(338–347) | 170–175<br>(338–347)          | 170–175<br>(338–347)          | 170–175<br>(338–347)                                  |
| Heat of fusion<br>(80 °C/176 °F to end of melting)                        | J/g<br>(BTU/lb)                               | 58–67<br>(25–29)     | 58–66<br>(25–28)              | 55–65<br>(23–28)              | 57–66<br>(24–28)                                      |
| Crystallization point   | °C<br>(°F)                                    | 134–144<br>(273–291) | 137–144<br>(279–291)          | 137–145<br>(279–293)          | 137–144<br>(279–291)                                  |
| Crystallization heat  | J/g<br>(BTU/lb)                               | 54–60<br>(23–26)     | 54–60<br>(23–26)              | 50–60<br>(21–26)              | 50–56<br>(21–24)                                      |
| VICAT point   | °C<br>(°F)                                    | 135–145<br>(275–295) | 135–145<br>(275–295)          | 135–145<br>(275–295)          | 135–145<br>(275–295) ASTM D1525<br>2A                 |
| Glass transition (Tg)   | °C<br>(°F)                                    | –40<br>(–40)         | –40<br>(–40)                  | –40<br>(–40)                  | –40<br>(–40) ASTM D4065                               |
| Molding shrinkage (linear)  | %   | 2–3                  | 2–3                           | 2–3                           | –   |
| Thermal stability   | °C<br>(°F)                                    | 375–400<br>(707–752) | >400<br>(>752) <sup>(1)</sup> | >400<br>(>752) <sup>(1)</sup> | 375–400<br>(707–752) TGA. T° for 1 %<br>w loss in air |
| Linear thermal expansion coefficient                                      | 10 <sup>–6</sup> /K<br>(10 <sup>–6</sup> /°F) | 140<br>(78)          | 140<br>(78)                   | 140<br>(78)                   | 140<br>(78) ASTM D696                                 |
| Thermal conductivity<br>at 23 °C/73 °F                                    | W/m·K<br>(BTU·in/h·ft <sup>2</sup> ·°F)       | 0.2<br>(1.4)         | 0.2<br>(1.4)                  | 0.2<br>(1.4)                  | 0.2<br>(1.4) ASTM C177                                |
| Specific heat   |   |                      |                               |                               |   |
| at 23 °C/73 °F  | J/g·K<br>(BTU/lb·°F)                          | 1.2<br>(0.28)        | 1.2<br>(0.28)                 | 1.2<br>(0.28)                 | 1.2<br>(0.28)   |
| at 100 °C/212 °F  | J/g·K<br>(BTU/lb·°F)                          | 1.6<br>(0.38)        | 1.6<br>(0.38)                 | 1.6<br>(0.38)                 | 1.6<br>(0.38)   |
| <b>Electrical properties</b>  |   |                      |                               |                               |   |
| Surface resistivity (voltage < 1 V,<br>after 2 min, 500 V at 23 °C/73 °F) | Ω   | ≥ 10 <sup>14</sup>   | ≥ 10 <sup>14</sup>            | ≥ 10 <sup>14</sup>            | ≥ 10 <sup>14</sup> ASTM D257                          |
| Volume resistivity (intensity =<br>10 mA, after 2 min at 23 °C/73 °F)     | Ω·cm  | ≥ 10 <sup>14</sup>   | ≥ 10 <sup>14</sup>            | ≥ 10 <sup>14</sup>            | ≥ 10 <sup>14</sup> ASTM D257                          |
| Dielectric strength<br>at 23 °C/73 °F, 1 mm thick                         | kV/mm   | 20–25                | 20–25                         | 20–25                         | 20–25 ASTM D149                                       |
| <b>Fire resistance</b>  |   |                      |                               |                               |   |
| UL-94 flammability test   | Class   | V–0                  | V–0                           | –                             | V–0 UL-94   |
| Limiting oxygen index<br>(sheet 3 mm thick)                               | %   | 44                   | 44                            | 44                            | 44 ASTM D2863   |

<sup>(1)</sup> Results achieved with formulated grade (code: XXXX/0000)

Mechanical properties are significantly affected by the sample preparation method.

Typical property values are reported in this document. They should not be interpreted as sales specifications.

|   | <b>Unit</b>                                | <b>Solef® 6020</b>       | <b>Solef® 5130</b>       | <b>Solef® 9007</b>       | <b>Test Method</b>   |
|---|--|--------------------------|--------------------------|--------------------------|----------------------|
| <b>Physical properties</b>                                  |  |                          |                          |                          |                      |
| Density at 23 °C/73 °F                                      | g/cm <sup>3</sup><br>(lb/ft <sup>3</sup> ) | 1.75–1.80<br>(110–112)   | 1.75–1.80<br>(110–112)   | 1.75–1.80<br>(110–112)   | ASTM D792            |
| Water absorption<br>(24 h at 23 °C/73 °F)                   | %  | < 0.04                   | < 0.2                    | < 0.04                   | ASTM D570            |
| Melt flow index (230 °C/446 °F)                             | g/10 min                                   |                          |                          |                          | ASTM D1238           |
| 21.6 kg   |  | ≤ 0.2                    | –                        | –                        |                      |
| 10 kg   |  | –                        | –                        | –                        |                      |
| 5 kg  |  | –                        | –                        | 20–38                    |                      |
| 3.8 kg  |  | –                        | –                        | 16–26                    |                      |
| 2.16 kg   |  | –                        | –                        | –                        |                      |
| <b>Mechanical properties</b>                                |  |                          |                          |                          |                      |
| Tensile at 23 °C/73 °F<br>(Type IV specimen, 2 mm thick)    |  |                          |                          |                          | ASTM D638            |
| Stress at yield<br>(50 mm/min)                              | MPa<br>(psi)                               | –                        | –                        | 45–60<br>(6,500–8,700)   |                      |
| Stress at break<br>(50 mm/min)                              | MPa<br>(psi)                               | –                        | –                        | 30–50<br>(4,400–7,300)   |                      |
| Elongation at yield<br>(50 mm/min)                          | %  | –                        | –                        | 5–10                     |                      |
| Elongation at break<br>(50 mm/min)                          | %  | –                        | –                        | 20–300                   |                      |
| Modulus<br>(1 mm/min)                                       | MPa<br>(kpsi)                              | 1,300–2,000<br>(188–290) | 1,000–1,500<br>(145–218) | 1,400–2,200<br>(200–320) |                      |
| Notched charpy strength<br>(4 mm thick, 2 m/s, 23 °C/73 °F) | J/m<br>(ft·lbf/in)                         | –                        | –                        | 40–120<br>(0.7–2.0)      | ASTM D6110           |
| IZOD impact (notched V 10 mm,<br>23 °C/73 °F, 4 mm thick)   | J/m<br>(ft·lbf/in)                         | –                        | –                        | –                        | ASTM D256            |
| Shore D hardness (2 mm thick)                               |  | –                        | –                        | 73–80                    | ASTM D2240           |
| Abrasion resistance   | mg/1,000 rev                               | –                        | –                        | 5–10                     | TABER CS 17,<br>1 kg |
| Friction coefficient  | static<br>dynamic                          | –                        | –                        | 0.2–0.4<br>0.15–0.35     | ASTM D1894           |

| Unit  | Solef® 6020                                   | Solef® 5130          | Solef® 9007          | Test Method          |
|---|---|----------------------|----------------------|----------------------|
| <b>Thermal properties</b>   |   |                      |                      |                      |
| Crystallinity by DSC  |   |                      |                      | ASTM D3418           |
| Melting point   | °C<br>(°F)                                    | 171–175<br>(340–347) | 158–166<br>(316–331) | 162–168<br>(324–334) |
| Heat of fusion<br>(80 °C/176 °F to end of melting)                        | J/g<br>(BTU/lb)                               | 55–65<br>(23–28)     | 40–48<br>(17–21)     | 53–60<br>(22–26)     |
| Crystallization point   | °C<br>(°F)                                    | 133–138<br>(271–280) | 124–130<br>(255–266) | 133–140<br>(271–284) |
| Crystallization heat  | J/g<br>(BTU/lb)                               | 48–55<br>(21–24)     | 37–45<br>(16–19)     | 53–60<br>(22–26)     |
| VICAT point   | °C<br>(°F)                                    | 135–145<br>(275–295) | –                    | –                    |
| Glass transition (Tg)   | °C<br>(°F)                                    | –40<br>(–40)         | –40<br>(–40)         | –40<br>(–40)         |
| Molding shrinkage (linear)  | %   | –                    | –                    | 2–3                  |
| Thermal stability   | °C<br>(°F)                                    | 375–400<br>(707–752) | >375<br>(>707)       | 375–400<br>(707–752) |
| Linear thermal expansion coefficient                                      | 10 <sup>-6</sup> /K<br>(10 <sup>-6</sup> /°F) | 140<br>(78)          | –                    | 140<br>(78)          |
| Thermal conductivity<br>at 23 °C/73 °F                                    | W/m·K<br>(BTU·in/h·ft <sup>2</sup> ·°F)       | 0.2<br>(1.4)         | –                    | 0.2<br>(1.4)         |
| Specific heat   |   |                      |                      |                      |
| at 23 °C/73 °F  | J/g·K<br>(BTU/lb·°F)                          | 1.2<br>(0.28)        | –                    | 1.2<br>(0.28)        |
| at 100 °C/212 °F  | J/g·K<br>(BTU/lb·°F)                          | 1.6<br>(0.38)        | –                    | 1.6<br>(0.38)        |
| <b>Electrical properties</b>  |   |                      |                      |                      |
| Surface resistivity (voltage < 1 V,<br>after 2 min, 500 V at 23 °C/73 °F) | Ω   | ≥ 10 <sup>14</sup>   | ≥ 10 <sup>14</sup>   | ≥ 10 <sup>14</sup>   |
| Volume resistivity (intensity =<br>10 mA, after 2 min at 23 °C/73 °F)     | Ω·cm  | ≥ 10 <sup>14</sup>   | ≥ 10 <sup>14</sup>   | ≥ 10 <sup>14</sup>   |
| Dielectric strength<br>at 23 °C/73 °F, 1 mm thick                         | kV/mm   | 20–25                | –                    | 20–25                |
| <b>Fire resistance</b>  |   |                      |                      |                      |
| UL-94 flammability test   | Class   | –                    | –                    | –                    |
| Limiting oxygen index<br>(sheet 3 mm thick)                               | %   | 44                   | –                    | 44                   |

Mechanical properties are significantly affected by the sample preparation method.

Typical property values are reported in this document. They should not be interpreted as sales specifications.

|   | <b>Unit</b>                                | <b>Solef® 9009</b>       | <b>Solef® 460</b>        | <b>Solef® 41308</b>      | <b>Test Method</b>   |
|---|--|--------------------------|--------------------------|--------------------------|----------------------|
| <b>Physical properties</b>                                  |  |                          |                          |                          |                      |
| Density at 23 °C/73 °F                                      | g/cm <sup>3</sup><br>(lb/ft <sup>3</sup> ) | 1.75–1.80<br>(110–112)   | 1.75–1.80<br>(110–112)   | 1.75–1.80<br>(110–112)   | ASTM D792            |
| Water absorption<br>(24 h at 23 °C/73 °F)                   | %  | < 0.04                   | < 0.04                   | < 0.04                   | ASTM D570            |
| Melt flow index (230 °C/446 °F)                             | g/10 min                                   |                          |                          |                          | ASTM D1238           |
| 21.6 kg   |  | –                        | 10                       | –                        |                      |
| 10 kg   |  | –                        | –                        | –                        |                      |
| 5 kg  |  | 10–20                    | –                        | 18–24                    |                      |
| 3.8 kg  |  | 7–13                     | –                        | –                        |                      |
| 2.16 kg   |  | –                        | –                        | 6–8                      |                      |
| <b>Mechanical properties</b>                                |  |                          |                          |                          |                      |
| Tensile at 23 °C/73 °F<br>(Type IV specimen, 2 mm thick)    |  |                          |                          |                          | ASTM D638            |
| Stress at yield<br>(50 mm/min)                              | MPa<br>(psi)                               | 45–60<br>(6,500–8,700)   | 35–55<br>(5,000–8,000)   | 45–50<br>(6,500–7,200)   |                      |
| Stress at break<br>(50 mm/min)                              | MPa<br>(psi)                               | 30–50<br>(4,400–7,300)   | 30–50<br>(4,400–7,300)   | 20–40<br>(2,900–5,800)   |                      |
| Elongation at yield<br>(50 mm/min)                          | %  | 5–10                     | 10–15                    | 5–10                     |                      |
| Elongation at break<br>(50 mm/min)                          | %  | 20–300                   | 20–300                   | 20–300                   |                      |
| Modulus<br>(1 mm/min)                                       | MPa<br>(kpsi)                              | 1,400–2,200<br>(200–320) | 1,000–1,500<br>(145–218) | 1,600–2,200<br>(230–320) |                      |
| Notched charpy strength<br>(4 mm thick, 2 m/s, 23 °C/73 °F) | J/m<br>(ft·lbf/in)                         | 40–120<br>(0.7–2.0)      | –                        | 40–120<br>(0.7–2.0)      | ASTM D6110           |
| IZOD impact (notched V 10 mm,<br>23 °C/73 °F, 4 mm thick)   | J/m<br>(ft·lbf/in)                         | –                        | 107<br>(2)               | –                        | ASTM D256            |
| Shore D hardness (2 mm thick)                               |  | 73–80                    | 73–80                    | –                        | ASTM D2240           |
| Abrasion resistance   | mg/1,000 rev                               | 5–10                     | 5–10                     | 5–10                     | TABER CS 17,<br>1 kg |
| Friction coefficient  | static<br>dynamic                          | 0.2–0.4<br>0.15–0.35     | 0.2–0.4<br>0.15–0.35     | 0.25–0.35<br>0.25–0.35   | ASTM D1894           |

| Unit  | Solef® 9009                                   | Solef® 460           | Solef® 41308         | Test Method  |
|---|---|----------------------|----------------------|--|
| <b>Thermal properties</b>   |   |                      |                      |  |
| Crystallinity by DSC  |   |                      |                      | ASTM D3418   |
| Melting point   | °C<br>(°F)                                    | 162–168<br>(324–334) | 155–160<br>(311–320) | 167–171<br>(333–339)                               |
| Heat of fusion<br>(80 °C/176 °F to end of melting)                        | J/g<br>(BTU/lb)                               | 53–60<br>(22–26)     | 42–50<br>(17–21)     | 50–55<br>(21–23)                                   |
| Crystallization point   | °C<br>(°F)                                    | 133–140<br>(271–284) | 128–135<br>(262–275) | 130–140<br>(266–284)                               |
| Crystallization heat  | J/g<br>(BTU/lb)                               | 53–60<br>(22–26)     | 42–50<br>(17–21)     | 48–54<br>(20–23)                                   |
| VICAT point   | °C<br>(°F)                                    | –                    | –                    | –<br>ASTM D1525<br>2A                              |
| Glass transition (Tg)   | °C<br>(°F)                                    | –40<br>(–40)         | –39<br>(–38)         | –40<br>(–40)<br>ASTM D4065                         |
| Molding shrinkage (linear)  | %   | 2–3                  | –                    | –  |
| Thermal stability   | °C<br>(°F)                                    | 375–400<br>(707–752) | 375–400<br>(707–752) | >375<br>(>707)<br>TGA. T° for 1 %<br>w loss in air |
| Linear thermal expansion coefficient                                      | 10 <sup>-6</sup> /K<br>(10 <sup>-6</sup> /°F) | 140<br>(78)          | 126<br>(70)          | 140<br>(78)<br>ASTM D696                           |
| Thermal conductivity<br>at 23 °C/73 °F                                    | W/m·K<br>(BTU·in/h·ft <sup>2</sup> ·°F)       | 0.2<br>(1.4)         | 0.2<br>(1.4)         | 0.2<br>(1.4)<br>ASTM C177                          |
| Specific heat   |   |                      |                      |  |
| at 23 °C/73 °F  | J/g·K<br>(BTU/lb·°F)                          | 1.2<br>(0.28)        | 1.2<br>(0.28)        | –  |
| at 100 °C/212 °F  | J/g·K<br>(BTU/lb·°F)                          | 1.6<br>(0.38)        | 1.6<br>(0.38)        | –  |
| <b>Electrical properties</b>  |   |                      |                      |  |
| Surface resistivity (voltage < 1 V,<br>after 2 min, 500 V at 23 °C/73 °F) | Ω   | ≥ 10 <sup>14</sup>   | ≥ 10 <sup>14</sup>   | ≥ 10 <sup>14</sup><br>ASTM D257                    |
| Volume resistivity (intensity =<br>10 mA, after 2 min at 23 °C/73 °F)     | Ω·cm  | ≥ 10 <sup>14</sup>   | ≥ 10 <sup>14</sup>   | ≥ 10 <sup>14</sup><br>ASTM D257                    |
| Dielectric strength<br>at 23 °C/73 °F, 1 mm thick                         | kV/mm   | 20–25                | 10                   | –<br>ASTM D149                                     |
| <b>Fire resistance</b>  |   |                      |                      |  |
| UL-94 flammability test   | Class   | V-0                  | V-0                  | –<br>UL-94   |
| Limiting oxygen index<br>(sheet 3 mm thick)                               | %   | 44                   | 44                   | –<br>ASTM D2863                                    |

Mechanical properties are significantly affected by the sample preparation method.

Typical property values are reported in this document. They should not be interpreted as sales specifications.

## Typical Properties of Solef® PVDF Copolymer Grades

| Unit  | Solef®<br>11010    | Solef®<br>21510        | Solef®<br>31508        | Solef®<br>60512                | Test Method                            |
|---|--------------------|------------------------|------------------------|--------------------------------|--|
| <b>Physical properties</b>                                  |                    |                        |                        |                                |  |
| Density at 23 °C/73 °F                                      | g/cm³<br>(lb/ft³)  | 1.75–1.80<br>(110–112) | 1.75–1.80<br>(110–112) | 1.75–1.80<br>(110–112)         | 1.75–1.80<br>(110–112)                 |
| Water absorption<br>(24 h at 23 °C/73 °F)                   | %                  | < 0.04                 | < 0.04                 | < 0.04                         | < 0.04                                 |
| Melt flow index (230 °C/446 °F)                             | g/10 min           |                        |                        |                                | ASTM D1238                             |
| 21.6 kg   |                    | –                      | –                      | –                              | –                                      |
| 10 kg   |                    | –                      | –                      | –                              | 2.5–4                                  |
| 5 kg  |                    | 4–8                    | 3–9                    | –                              | –                                      |
| 3.8 kg  |                    | –                      | –                      | –                              | –                                      |
| 2.16 kg   |                    | –                      | –                      | 3–8                            | –                                      |
| <b>Mechanical properties</b>                                |                    |                        |                        |                                |  |
| Tensile at 23 °C/73 °F<br>(Type IV specimen, 2 mm thick)    |                    |                        |                        |                                | ASTM D638                              |
| Stress at yield<br>(50 mm/min)                              | MPa<br>(psi)       | 20–35<br>(2,900–5,000) | 15–18<br>(2,175–2,610) | 14–35<br>(2,030–5,075)         | 34–40<br>(4,930–5,800)                 |
| Stress at break<br>(50 mm/min)                              | MPa<br>(psi)       | 20–40<br>(2,900–5,800) | 20–40<br>(2,900–5,800) | 14–30<br>(2,030–4,350)         | 34–40<br>(4,930–5,800)                 |
| Elongation at yield<br>(50 mm/min)                          | %                  | 10–12                  | 12–15                  | 10–12                          | 9–12                                   |
| Elongation at break<br>(50 mm/min)                          | %                  | 200–600                | 600–750                | 350–600                        | 100–300                                |
| Modulus<br>(1 mm/min)                                       | MPa<br>(kpsi)      | 800–1,200<br>(120–180) | 360–480<br>(52–70)     | 400–600<br>(58–87)             | 1,250–1,400<br>(181.3–203)             |
| Notched charpy strength<br>(4 mm thick, 2 m/s, 23 °C/73 °F) | J/m<br>(ft·lbf/in) | 150–200<br>(3–5)       | –                      | –                              | 400–1,000<br>(7.5–18.7) <sup>(2)</sup> |
| IZOD impact (notched V 10 mm,<br>23 °C/73 °F, 4 mm thick)   | J/m<br>(ft·lbf/in) | –                      | 180<br>(3.37)          | 1,000<br>(18.7) <sup>(2)</sup> | –                                      |
| Shore D hardness (2 mm thick)                               |                    | 70–75                  | 58–62                  | 50–55                          | 70                                     |
| Abrasion resistance   | mg/1,000 rev       | 5–15                   | 5–15                   | 5–10                           | 5–10                                   |
| Friction coefficient  | static<br>dynamic  | 0.2–0.4<br>0.15–0.35   | 0.2–0.4<br>0.15–0.35   | 0.2–0.4<br>0.15–0.35           | 0.2–0.4<br>0.2–0.3                     |
| <sup>(2)</sup> Partial break                                |                    |                        |                        |                                |  |

| Unit  | Solef®<br>11010                               | Solef®<br>21510      | Solef®<br>31508      | Solef®<br>60512      | Test Method   |
|---|---|----------------------|----------------------|----------------------|---|
| <b>Thermal properties</b>   |   |                      |                      |                      |   |
| Crystallinity by DSC  |   |                      |                      |                      | ASTM D3418  |
| Melting point   | °C<br>(°F)                                    | 158–162<br>(316–324) | 130–136<br>(266–277) | 167–171<br>(333–339) | 170–174<br>(338–345)                                  |
| Heat of fusion<br>(80 °C/176 °F to end of melting)                        | J/g<br>(BTU/lb)                               | 35–40<br>(15–18)     | 20–24<br>(9–10)      | 23–29<br>(8.2–14.2)  | 41–50<br>(18–21.5)                                    |
| Crystallization point   | °C<br>(°F)                                    | 115–130<br>(239–266) | 89–93<br>(192–199)   | 125–131<br>(259–265) | 142–146<br>(288–295)                                  |
| Crystallization heat  | J/g<br>(BTU/lb)                               | 30–40<br>(13–18)     | 20–24<br>(9–10)      | 22–28<br>(7–13)      | 42–50<br>(18–21.5)                                    |
| VICAT point   | °C<br>(°F)                                    | 90–105<br>(194–220)  | 155<br>(239)         | 110<br>(230)         | 167<br>(333) ASTM D1525<br>2A                         |
| Glass transition (Tg)   | °C<br>(°F)                                    | –35<br>(–31)         | –40<br>(–40)         | –28<br>(–18)         | –40<br>(–40) ASTM D4065                               |
| Molding shrinkage (linear)  | %   | 2–3                  | 2–3                  | 2–3                  | 2–3   |
| Thermal stability   | °C<br>(°F)                                    | 330–350<br>(626–662) | 340–375<br>(644–707) | 320–340<br>(608–644) | 320–340<br>(608–644) TGA. T° for 1 %<br>w loss in air |
| Linear thermal expansion coefficient                                      | 10 <sup>–6</sup> /K<br>(10 <sup>–6</sup> /°F) | 180<br>(100)         | 180<br>(100)         | 130–150<br>(72–83)   | 130–180<br>(72–100) ASTM D696                         |
| Thermal conductivity<br>at 23 °C/73 °F                                    | W/m·K<br>(BTU·in/h·ft <sup>2</sup> ·°F)       | 0.19<br>(1.3)        | 0.18<br>(1.2)        | 0.2<br>(1.4)         | 0.2<br>(1.4) ASTM C177                                |
| <b>Specific heat</b>  |   |                      |                      |                      |   |
| at 23 °C/73 °F  | J/g·K<br>(BTU/lb·°F)                          | 1.2<br>(0.28)        | 1.2<br>(0.28)        | 1.2<br>(0.28)        | 1.2<br>(0.28)   |
| at 100 °C/212 °F  | J/g·K<br>(BTU/lb·°F)                          | 1.6<br>(0.38)        | 1.6<br>(0.38)        | 1.6<br>(0.38)        | 1.6<br>(0.38)   |
| <b>Electrical properties</b>  |   |                      |                      |                      |   |
| Surface resistivity (voltage < 1 V,<br>after 2 min, 500 V at 23 °C/73 °F) | Ω   | ≥ 10 <sup>14</sup>   | ≥ 10 <sup>14</sup>   | ≥ 10 <sup>14</sup>   | ≥ 10 <sup>14</sup> ASTM D257                          |
| Volume resistivity (intensity =<br>10 mA, after 2 min at 23 °C/73 °F)     | Ω·cm  | ≥ 10 <sup>14</sup>   | ≥ 10 <sup>14</sup>   | ≥ 10 <sup>14</sup>   | ≥ 10 <sup>14</sup> ASTM D257                          |
| Dielectric strength<br>at 23 °C/73 °F, 1 mm thick                         | kV/mm   | 15–25                | 15–20                | 20–25                | – ASTM D149   |
| <b>Fire resistance</b>  |   |                      |                      |                      |   |
| UL-94 flammability test   | Class   | V–0                  | –                    | V–0                  | – UL-94   |
| Limiting oxygen index<br>(sheet 3 mm thick)                               | %   | 44 <sup>(3)</sup>    | 44 <sup>(3)</sup>    | 48                   | – ASTM D2863  |

<sup>(3)</sup> Formulations with higher values available: the Limiting Oxygen Index of the /0003 formulation is 65 %; the Limiting Oxygen Index of the /0009 formulation is > 90 %.

Mechanical properties are significantly affected by the sample preparation method.

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