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## Product Information

# Ultrason<sup>®</sup> E 2020 P, P SR and P SR Micro

BASF's Ultrason E polyethersulfones are amorphous high-performance thermoplastics, functioning as heat-resistant impact modifiers in thermoset resins and composites. Specific grades are available in the form of flakes, functionalized flakes and functionalized powders, optimized for easy incorporation into epoxy resins. On account of their thermo-mechanical characteristics and favorable fire, smoke and toxicity (FST) properties, Ultrason E polyethersulfones impart higher impact resistance and improved flame retardance to epoxy-based formulations and prepregs.

### Overcoming the brittleness of epoxy resin and prepregs

The most limiting constraint to the use of epoxy-based composites manufactured by wet or dry hand lay-up techniques is the inherent brittleness of these materials. Adding Ultrason E polyethersulfones to the epoxy mitigates this problem by reducing the cracking tendency and increasing the impact strength of glass and carbon filled prepregs without compromising high glass transition temperatures, modulus and strength-to-weight ratios. As an added benefit, the inherently flame retardant Ultrason E polyethersulfones contributes to improved FST properties of the composite.

### Features

- High glass transition temperature
- High limiting oxygen index
- Available in the form of flakes and powder
- Available with hydroxy-functionalization
- Functionalized grades soluble in epoxy up to 25 wt%

### Benefits for epoxy-based resins and composites

- Can be used to adjust viscosities
- Impact modification (≥30% higher impact resistance)
- Improved flame retardance

## Specialty polyethersulfone grades for easy incorporation into epoxy

BASF offers three grades suitable for epoxy impact modification. Their product forms are designed for easy incorporation into epoxy. The flake form of Ultrason E 2020 P facilitates the dissolution in epoxy. Ultrason E 2020 P SR, also in the form of flakes, is hydroxy-functionalized for covalent bonding to the epoxy matrix, enhancing the compatibility with the matrix material. Ultrason E 2020 P SR micro is a hydroxy-functionalized, micronized powder, offering optimal features for easy dissolution and compatibility. Typically, up to 25 wt% of the functionalized grades can be dissolved in epoxy.

The bulk/mechanical properties of the Ultrason E 2020 P specialty grades are typical of high performance amorphous thermoplastics. Additional properties such as viscosity, hydroxy content and particle sizes define the quality of functionalized grades. Ultrason E 2020 P SR (micro) excels in terms of low viscosities and high hydroxy contents.

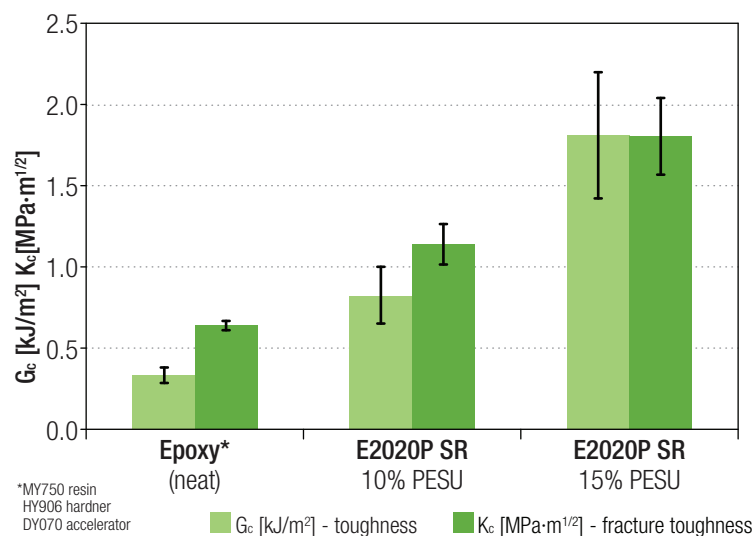
### Impact modification of epoxy

Owing to its thermo-mechanical characteristics and functional specifics, Ultrason E 2020 P SR (micro) is particularly efficient in improving the impact resistance of epoxy resin-based materials. For example, in anhydride-cured epoxy, the addition of 10 wt% and 15 wt% Ultrason E 2020 P results in significant increases in fracture toughness  $K_{Ic}$  and toughness  $G_{Ic}$ .

### Physical and Chemical Properties of Ultrason E 2020 Grades

Grade range	E 2020 P	E 2020 P SR	E 2020 P SR micro
Viscosity number, [cm <sup>3</sup> /g]	56	59	59
Tg, [°C]	225	225	225
Moisture absorption, %	1	1	1
Apparent density, [g/cm <sup>3</sup> ]	0.25	0.3	0.3
Tensile modulus, [MPa]	2,700	n.m.	n.m.
Tensile strength, [MPa]	90	n.m.	n.m.
HDT A (1.8 MPa), [°C]	205	n.m.	n.m.
Molecular weight, [g/mol]	48,000	55,000	55,000
Hydroxy end groups content, %	-	≥50	≥50
Particle size, Dv50 [μm]	-	-	25
Dv100 [μm]	-	-	100

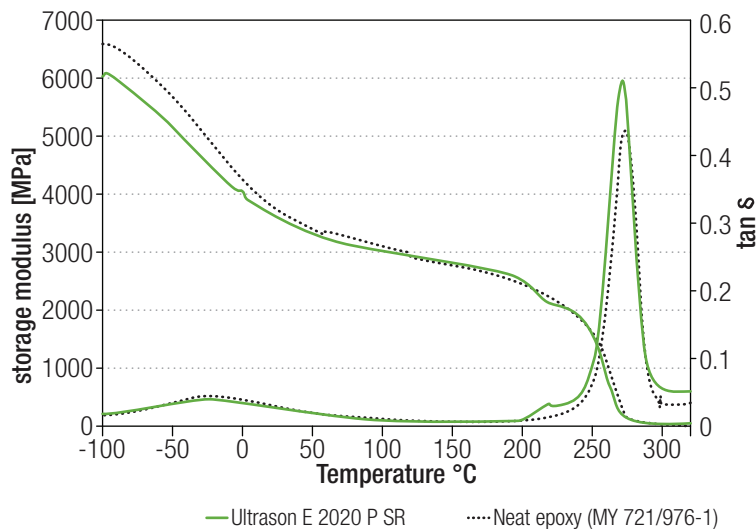
n.m. – not measured



High performance epoxies can take advantage of the improved impact resistance without compromising on the high glass transition temperature and stiffness. This can be seen from the temperature dependence of tan delta and storage modulus for neat epoxy and modified with Ultrason E 2020 P SR, respectively.

### Positive contribution to FST properties

Ultrason E 2020 P SR (micro) grades differ from natural Ultrason E merely in terms of product form and/or functionalization. They share the inherent flame retardance of all polyarylethersulfones. Consequently, they will improve the overall FST properties of epoxy-based composites that do not otherwise contain flame retardants.



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