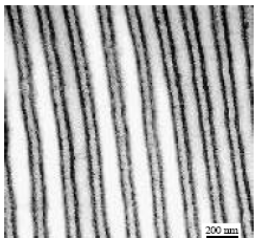
NANOSTRENGTH®

Epoxy

Functional Additives

Product Description

A new class of triblock copolymers based on Arkema's unique polymerization chemistries, Nanostrength® is currently available in two versions. One is an **SBM** copolymer of polystyrene, 1,4-polybutadiene and syndiotactic poly (methyl methacrylate). The other is a symmetric **MAM** copolymer with a center block of poly (butyl acrylate) surrounded by two blocks of poly (methyl methacrylate). Nanostrength® self-organizes on a nanometer scale. This nanostructuration is induced by the strong repulsions between the side and middle blocks. It is primarily governed by thermo-dynamics and is independent of processing conditions.



An example of nanostructure of a SBM

The thermodynamic miscibility leads to a homogenous and reproducible dispersion on Nanostrength® on a nanometer scale in the host polymer. This organization results in a new set of properties, such as impact strength, high rigidity and transparency**.**

SBM block copolymers have both a polar and non-polar moiety on the same molecule. As such, they are ideal interfacial agents for many incompatible systems, offering innovative possibilities in the design of new polymer blends, elastomers and composites. In addition, **SBM** are polymerized using a new patented ARKEMA anionic technology which leads to a highly syndiotactic structured **PMMA** block. Compared with conventional PMMA, s-**PMMA** is thermally more stable and is compatible with a number of industrial polymers, with a high glass transition temperature (130°C - 140°C) that does not compromise the heat distortion temperature of many polymers.

Suggestions for Use

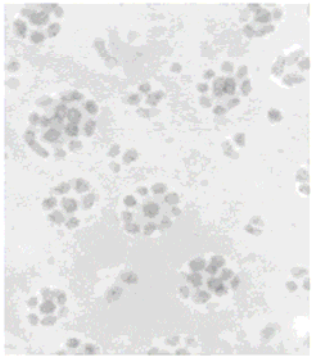
For thermoset applications, Nanostrength® is offered in powder forms. The powders can be dissolved in many epoxy precursors by heating/stirring process (between 80° and 135°C), by using a co-solvent (for instance toluene or MEK) or by dissolution in the curing agent. Typical dosages range from 3 to 10% for toughening or compatibilization. At higher loadings, Nanostrength® can not only be used for their usual properties, but the rheology modification they will confer to the system will allow for innovative processing of thermoset systems.

Commercial SBM Grades

E21 Medium MW with high butadiene content, good for structural applications (improved version of **E20** *(also still commercial)*)

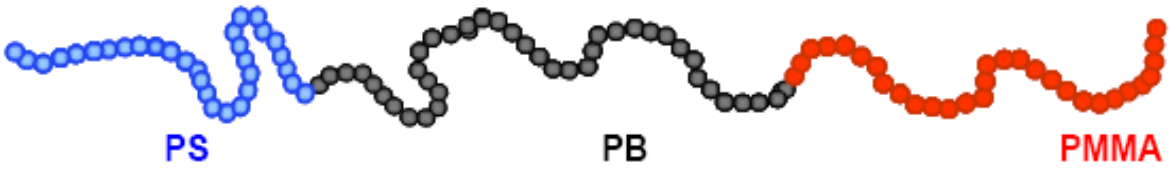
E41 Low MW with medium butadiene content, low increases in viscosity, good for electronic applications (improved version of **E40** *(also still commercial)*)

E21, E41, E20, E40 are grades that we recommend for epoxies



An example of nanostructuration: epoxy resin modified with SBM block copolymer (TEM)

SBM:



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Viscosity

	Neat	E21	E41
Solution viscosity (mPa.s in 10% toluene)	**----**	6	3
Viscosity (mPa.s) in DGEBA EEW=185 (ref=60) (10%, 80°C)	60	1060	400
Viscosity (mPa.s) in DGEBA EEW=185 (ref=10) (10%, 120°C)	15	270	65

Properties in DGEBA Epoxy Systems (10% Loading of Additive)

	Neat Epoxy	E21	E41
DGEBA/Jeffamine			
Tg	92	97	-
K_{1C}	0.76	2.91	-
G_{1C}	183	3940	-
DGEBA/DICY			
Tg	148	148	152
K_{1C}	0.88	1.35	1.68
DGEBA/MDEA			
Tg	170	176	177
K_{1C}	0.74	0.93	1.08
G_{1C}	258	TBD	418

Tg given in °C. G_{1C} given in J/m^2.

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