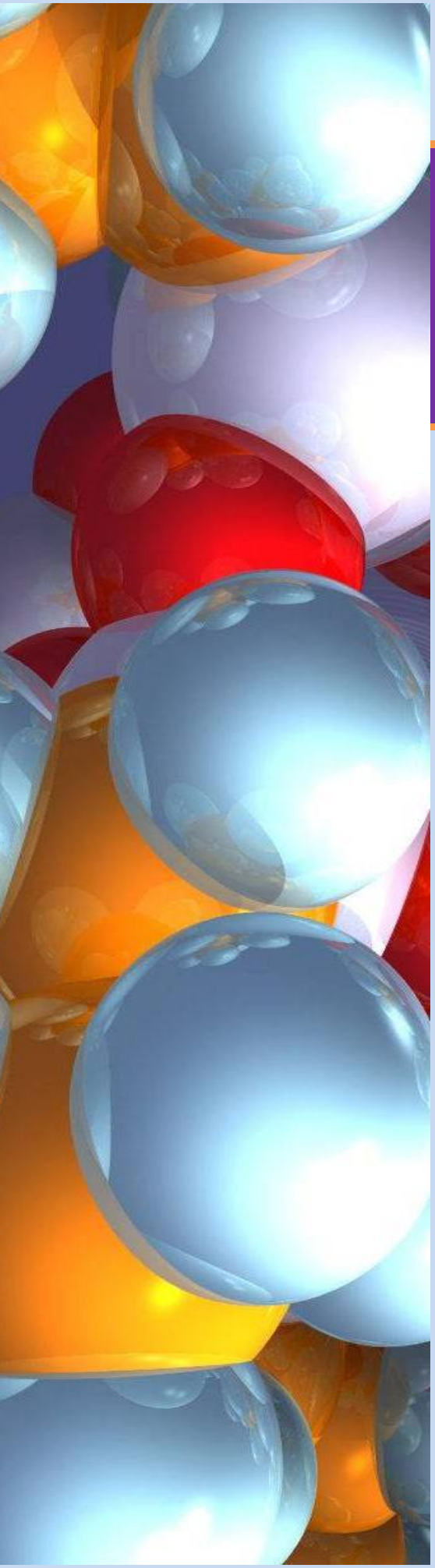


POSS® Enhanced Thermosets

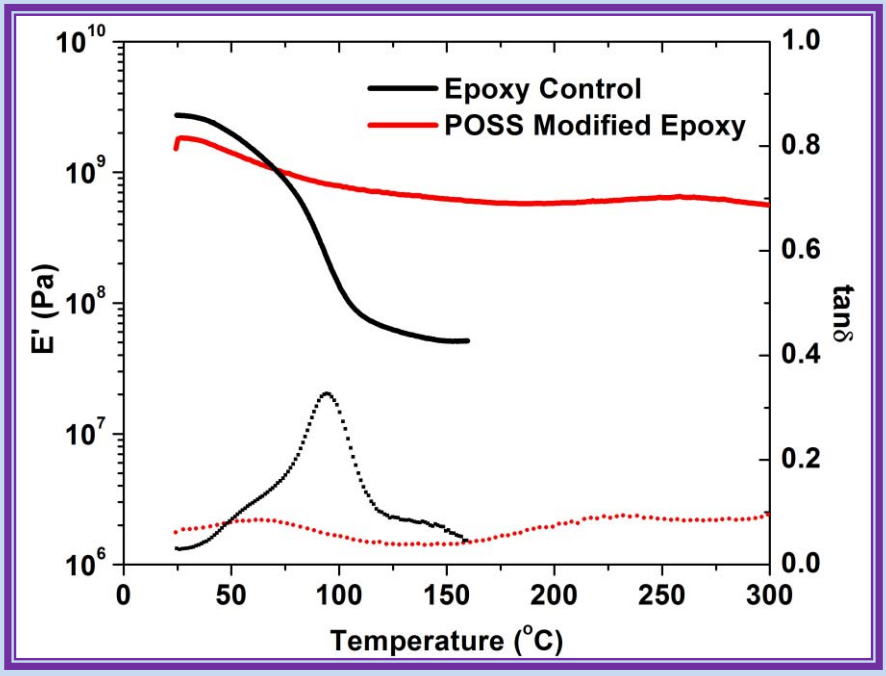
POSS® Enhanced Thermosets

- High temperature performance
- Increased solvent resistance
- Compatible with a wide range of resin types

POSS® Thermoset Materials

Due to their excellent compatibility with common monomers, functionalized POSS® molecules can be easily incorporated into various kinds of formulations. Typical enhancements include higher use temperature, resistance to water and solvent, scratch/wear resistance, improved mechanical properties, and resistance to environmental damage such as oxidation, UV degradation and erosion.

POSS® Enhanced Epoxies: In epoxy formulations, POSS® molecules are especially useful for raising the glass transition and maximum use temperatures. In the case of a POSS® dominated network, the resulting epoxy maintains modulus to very high temperatures. Conventional epoxies lose most of the strength as well as adhesion to materials above Tg.



The low viscosity of Glycidyl POSS® cage mixture (EP0409), and fast reaction with aliphatic amines, makes it suitable for room temperature VARTM without changing the typical process parameters. The POSS® modified composite materials have much higher use temperatures and can tolerate very high temperature thermal spikes. POSS® epoxies also have excellent solvent resistance making them suited to medical and electronic applications.

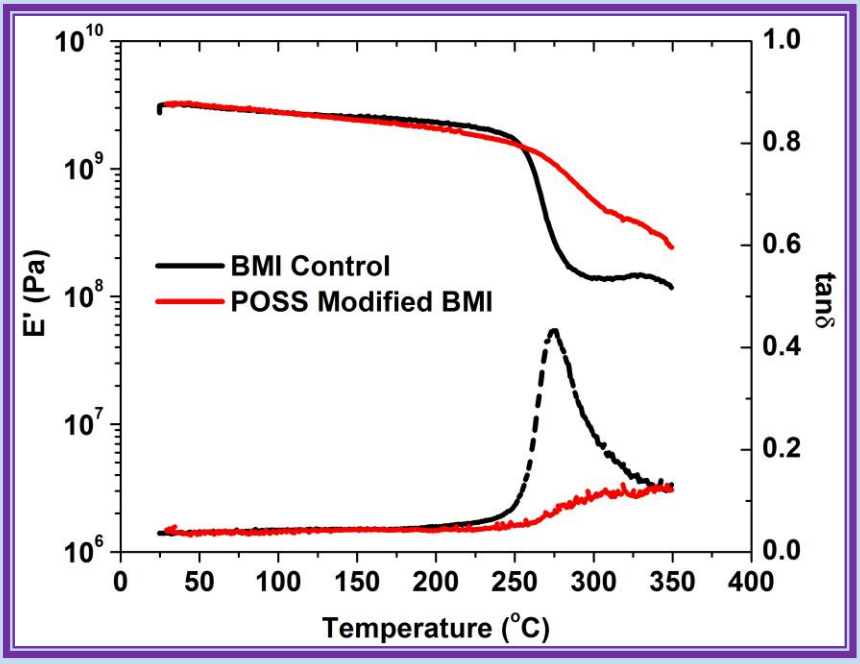
- POSS® Bond EP3110 — Oxidation resistant adhesive
- POSS® Bond EP3112 — Room temperature curable adhesive
- POSS® Resin EP3510 — High use temperature resin
- POSS® Resin EP3512 — Room temperature VARTMable resin
- POSS® Bond EP3120 — Oxidation resistant adhesive
- POSS® Resin EP3530 — High use temperature resin with long pot life at elevated temperatures
- POSS® Resin EP3532 — Long pot life, high Tg resin
- POSS® Resin EP3130 — Fast cure epoxy resin

POSS® Enhanced Acrylates: POSS® acrylate and methacrylate monomers are found to be very suitable for UV curing. High functionality POSS® acrylates and methacrylates (e.g. MA0735 and MA0736) are miscible with most of the commodity monomers and are excellent choices for improving the scratch and wear resistance of a UV coating. Improvements in hardness and strength are also common merits obtained by the addition of POSS®.

For UV cured adhesives, POSS® acrylates and methacrylates enhance the strength and substrate adhesion. POSS® enhanced acrylate adhesives are reported to improve the surface properties such as stain resistance and hydrophobicity, hence their use in dental applications.

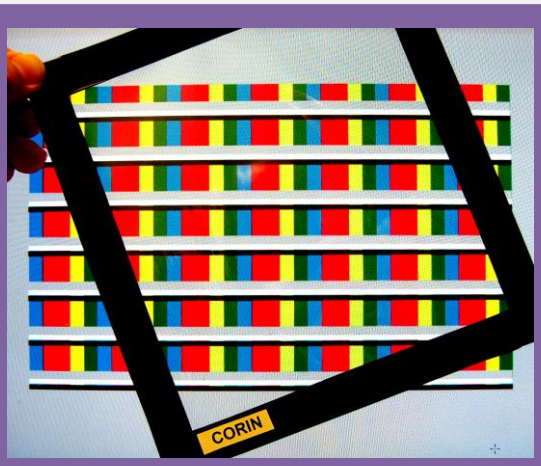
- POSS® Bond MA2110 — Scratch and stain resistant adhesive for dental and optical applications
- POSS® Coat MA2310 — Scratch resistant UV coating for plastics

POSS® Enhanced Bismaleimide: The robust silicon-oxygen core and high degradation temperature of the POSS® molecules enable them to be used in high temperature resins such as bismaleimide (BMI). Strong thermal performance of POSS® enhanced material leads to higher use temperature because mechanical properties are maintained, even at extreme temperatures.



- POSS® Resin BM9310 — High use temperature BMI resin for composites

POSS® Enhanced Polyimide: A unique colorless polyimide, Corin™, was developed by ManTech Technology using POSS®. Corin™ is highly transparent with a UV cutoff at 375nm (at 25µ thickness). Corin™ can be manufactured into sheets or sprayable coatings. Corin™ can be sprayed onto a variety of substrates with good adhesion to form a strong and tough coating. Corin™ has a glass transition temperature around 250°C which enables use in high temperature applications.



Corin™ XLS Colorless Polyimide

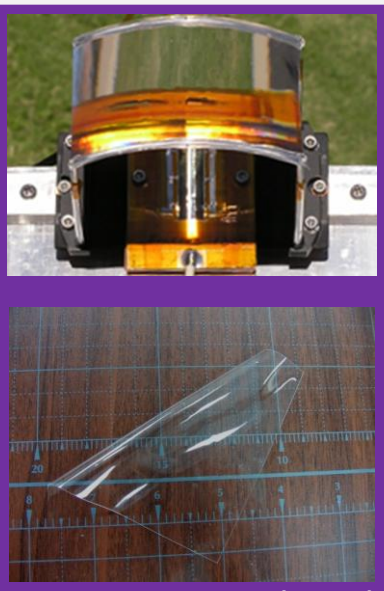
POSS® is also incorporated into polyamic acid to enhance the impact and oxidation resistance. IM9710, another POSS® enhanced polyimide shows better resistance to impact and atomic oxygen. Such property improvements dramatically increase the survivability of the material in a harsh environment such as low Earth orbit.

Mechanical					
Tensile Strength at 23 °C (73 °F)	D282	74	MPa	11	ksi
Tensile Modulus at 23 °C (73 °F)	D282	2.13	GPa	310	ksi
Tensile Elongation at 23 °C (73 °F)	D282	8.0	%	8.0	%
Thermal					
Glass Transition Temperature (DSC)	E1356-03	266	°C	511	°F
Glass Transition Temperature (DMA)	E1356-03	251	°C	483	°F
Linear CTE (125 °C – 175 °C, 1 mil)	E831-06	68	µm/m/°C	38	µin/in/°F

- POSS® Guard IM9710 — Impact and radiation resistant polyimide sheets
- POSS® Coat IM9310 — High performance wire/cable enamel
- CORIN™ XLS — Colorless, transparent, sprayable polyimide coating/sheets

POSS® Enhanced Silicones: Some POSS® molecules can be mixed with silicone to modify the strength and hardness without reducing the transparency. The main benefit is much improved resistance to oxidation and radiation including atomic oxygen, proton, and ultraviolet. This makes these POSS® enhanced silicones excellent choices for space applications where regular silicone fails to survive the surrounding radiation. Additional benefits include reduced solvent swelling plus better abrasion and wear resistance.

- **POSS® Coat SC4300** Optically clear silicone coating for electronic applications
- **POSS® Coat SC4302** Optically clear silicone coating for electronic applications, medium POSS® loading level
- **POSS® Coat SC4304** Optically clear silicone coating for electronic applications, high POSS® loading level
- **POSS® Resin SC4500** Non-halogenated thermal barrier composite material



POSS® Silicone Lens (upper)
Solar Cell Cover Sheet (lower)

POSS® Enhanced Resorcinols: POSS® can be used as fire retardant agents or synergists. An example is phenolic/resorcinol resins, where superior high temperature stability, excellent char retention, and enhanced insulation performance were observed.

- **Mark VI** Outstanding thermal barrier material for composites
- **Thermoguard** High performance thermal barrier coatings

POSS® Resorcinol in a Torch Test

Nanostructured® POSS® Epoxies and Amines

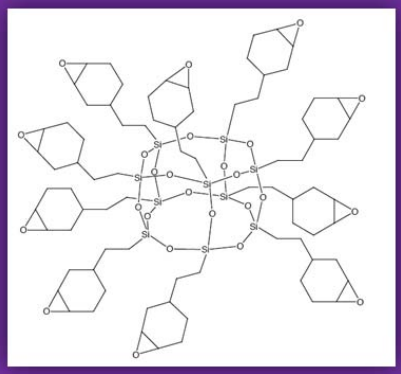
Functionalized POSS® epoxies are *fully miscible* with almost all the common epoxy monomers in the market. Multi-functional POSS® epoxies form networks with a high degree of crosslinking. Mono-functional POSS® epoxies can graft to the matrix resulting in higher glass transition temperature. The POSS® amines are used as co-curatives for epoxies to obtain better mechanical performance.

EpoxyCyclohexyl POSS® Cage Mixture (EP0408)

- $(C_8H_{13}O)_n(SiO_{1.5})_n$ n=8,10,12
- Soluble in IPA, THF and chloroform
- Curable with anhydrides and amines
- EEW 177 Density 1.24gcm^{-3} Viscosity>500P@60°C
- High thermal stability (>300°C)
- Increased high use temperature (up to 300°C)
- Excellent water and solvent resistance
- Enhanced thermomechanical performance

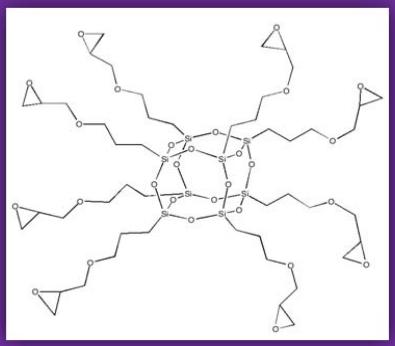
Glycidyl POSS® Cage Mixture (EP0409)

- $(C_6H_{11}O_2)_n(SiO_{1.5})_n$ n=8,10,12
- Soluble in toluene, THF and chloroform
- Curable with aliphatic and aromatic amines
- EEW 167 Density 1.25gcm^{-3} Viscosity 48P@25°C
- Fast cure
- Suitable for RTM or VARTM @ room temperature
- High thermal stability (>250°C)
- Increased high use temperature (up to 250°C)
- Excellent water and solvent resistance
- Enhanced thermomechanical performance



EP0408

EP0409



POSS Type		Formula	Appearance
EpoxyCyclohexylIsobutyl POSS	**EP0402**	$C_{36}H_{76}O_{13}Si_8$	White powder
GlycidylEthyl POSS	**EP0417**	$C_{20}H_{46}O_{14}Si_8$	White powder
GlycidylIsobutyl POSS	**EP0418**	$C_{34}H_{74}O_{14}Si_8$	White powder
GlycidylIsooctyl POSS	**EP0419**	$C_{62}H_{130}O_{14}Si_8$	Viscous liquid
GlycidylPhenyl POSS	**EP0425**	$C_{48}H_{46}O_{14}Si_8$	White powder
AminopropylIsobutyl POSS	**AM0265**	$C_{31}H_{71}NO_{12}Si_8$	White powder
AminopropylIsooctyl POSS	**AM0270**	$C_{59}H_{127}NO_{12}Si_8$	Viscous liquid
Aminopropylphenyl POSS	**AM0273**	$C_{129}H_{113}NO_{12}Si_8$	White powder
AminoethylaminopropylIsobutyl POSS	**AM0275**	$C_{33}H_{76}N_2O_{12}Si_8$	White powder
N-Phenylaminopropyl POSS	**AM0281**	$C_{89}H_{140}N_9O_{24}Si_6$	Viscous liquid

Nanostructured® POSS® Acrylates and Methacrylates

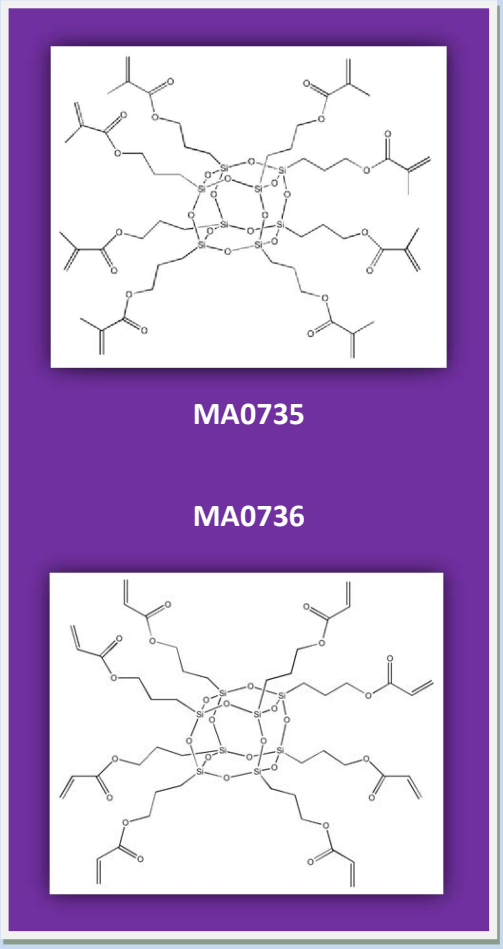
Functionalized POSS® acrylates and methacrylates are *fully miscible* with almost all common monomers in the market. They can be cured under ultraviolet or electron beam. Multi-functional POSS® acrylates and methacrylates are especially suitable for applications that require scratch resistance and enhanced mechanical performance.

Methacryl POSS® Cage Mixture (MA0735)

- $(C_7H_{11}O_2)_n(SiO_{1.5})_n$ n=8,10,12
- Low viscosity
- Fast UV cure
- Non-yellowing
- Miscible with acrylate and methacrylate monomers
- Density 1.20gcm^{-3} Viscosity 18 Poise @25°C
- High functionality offers excellent scratch resistance
- Increased service temperature
- Excellent moisture resistance
- Enhanced mechanical performance

Acrylo POSS® Cage Mixture (MA0736)

- $(C_6H_9O_2)_n(SiO_{1.5})_n$ n=8,10,12
- Low viscosity
- Fast UV cure
- Non-yellowing
- Miscible with acrylate and methacrylate monomers
- Density 1.23gcm^{-3} Viscosity 22 Poise @25°C
- High functionality offers excellent scratch resistance
- Increased service temperature
- Excellent moisture resistance
- Enhanced mechanical performance



MA0735

MA0736

POSS Type		Formula	Appearance
AcryloIsobutyl POSS	**MA0701**	$C_{34}H_{72}O_{14}Si_8$	White powder
MethacrylIsobutyl POSS	**MA0702**	$C_{35}H_{74}O_{14}Si_8$	White powder
MethacrylEthyl POSS	**MA0717**	$C_{21}H_{46}O_{14}Si_8$	White powder
MethacrylIsooctyl POSS	**MA0719**	$C_{63}H_{130}O_{14}Si_8$	Oil
MethacrylPhenyl POSS	**MA0734**	$C_{49}H_{46}O_{14}Si_8$	White powder

Hybrid Plastics is one of the top 10 nanotechnology companies in the United States. It is a spin-off of the Air Force Research Laboratory at Edwards Air Force Base in California. POSS® technology is the only major category of nanotechnology which remains controlled by one company. In 2005, the President of the United States designated POSS® technology to be in the strategic national interest of the United States.

The POSS® (Polyhedral Oligomeric Silsesquioxane) compounds are being hailed as the next big leap in plastics and molecular technology, and represent the first new class of chemical feedstocks to be developed in 50 years. They are affordable and cost competitive, and represent an entirely new, recyclable polymer feedstock - one that *marries the beneficial properties of plastics (processability and toughness) with those of ceramics (hardness and stability*). Significantly, POSS® based technology allows substantial redirection to more innocuous and abundant natural resources. *Silicates and sand are the equivalent of crude oil for POSS® Nanostructured® materials.* Finally, the POSS® technology can be incorporated directly into existing formulations without modifying manufacturing processes. The result is immediate turn-key applicability and usability.

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