EEMS®

Better Materials for Harsh Environments ™

CSO-500 Series Polymers
Liquid Polymers for Very High Temperature Ceramic Applications

Typical Applications: Low to medium viscosity liquid ceramic precursor resin used to infiltrate fiber performs and powder compacts to form a ceramic matrix. Used in the manufacture of ceramic matrix composites (CMCs) designed for long term operation at greater than 1200°C (2200°F). Also can be used as a high temperature stable binder for ceramic powders and as a sealer/infiltrant for porous ceramic and composite materials.
CSO 500 Series polymers can be used for up to 50 hours at 1600°C (2900°F).

Attributes of CSO-500 Series Polymers:

- Low viscosity, air stable liquids
- Low odor
- Once catalyzed, the pot life is 5-10 days (depending on catalyst concentration), gels as low as 110°C in 30 - 60 minutes, and roughly 10 minutes at 130°C
- Pyrolyzes to glass-ceramic in nitrogen at 850-1000°C
- 78-85% ceramic yield by mass from liquid resin after pyrolysis with proper catalyst depending on formulation
- Pyrolyzed ceramic is stable in air for long times up to 1300°C
- Pyrolyzed ceramic is stable for up to 50 hours at 1600°C in air after 850°C pyrolysis
- Compatible with most ceramic powders, and carbon/ceramic fibers

Typical Polymer Specification:

Parameter	**Standard value**
Appearance	water clear, or slightly turbid liquid
Viscosity	10-20 cps
Specific Gravity @ 25°C	0.99 – 1.06
Flash Point	> 92°C (>197°F)

Decomposition Temperature	260-300°C

Provided as a 100% solids neat resin - but can be diluted in solvents if needed

Recommended Solvents:	hexane, acetone, THF, toluene, xylenes, some alcohols, insoluble in water
Recommended Catalyst:	CLC-PL005 platinum catalyst, CLC-PB055 combination catalyst

Cure Parameters using a Platinum Catalyst

For Ceramic Applications:

1. Add 1% catalyst by polymer mass to the resin and stir in thoroughly
2. Fabricate/Infiltrate by VARTM, wet layup, or compression molding
3. Heat in air at 2°C/min and hold at temperature according to the following cycle: 60°C hold for 30 minutes, 90°C, hold for 2 hours; to 110-120°C, hold for 2 hours
4. A Hard cure at 210°C to 250°C for 1-2 hours in air or inert gas is recommended for improved handling strength and highest ceramic yield
5. Follow Pyrolysis Instructions in next section

Pyrolysis Parameters for cured components less than 5 mm thick:

1. Place in an inert gas capable furnace
2. Heat at 1°C/minute to 850-900°C under inert gas and hold at temperature for 1-2 hours
3. Cool at no greater than 5°C/minute until below 50°C

For components greater than 5 mm thick, contact EEMS, LLC for recommend thick part pyrolysis instructions.

Reinfiltration of Porous Materials

Re-infiltration and pyrolysis is typically needed to produce fully dense CMC components and to seal porous materials. Vacuum is needed to remove air from the pores and micro-pores in the material.

The part to be infiltrated should be placed into a liquid tight tray or mold, in a vacuum tight container and evacuated to a vacuum of better than 200 millitorr. The vacuum should be held for a minimum of 30 minutes. The resin can then be allowed into the chamber until the component is immersed, the vacuum should be maintained for a minimum of 30 minutes prior to admitting air into the chamber to restore atmospheric pressure.

Once the part is cured, it can be pyrolyzed as instructed above.

Curing and pyrolysis can be done in one step if the container/mold is made of steel, ceramic, or graphite, and can withstand pyrolysis temperatures.
The number of re-infiltration and pyrolysis cycles needed for a CMC is dependent upon the initial porosity of the perform and the desired final porosity of the component, but ranges from 1 cycle for filter media, up to 7-8 cycles for a non-woven felt perform with only 25% fiber volume.

Warranty:

The data provided relates only to the product noted above. The information is correct to the best of our knowledge, EEMS®, Inc. does not guarantee any properties. Because conditions and methods of use of our products are beyond our control, this information should not be used as a substitution for users own tests to ensure that EEMS products are safe, effective, and fully satisfactory for the intended end use. EEMS's sole warranty is that the product will meet sales specifications in effect at the time of shipment.

Data Sheet Rev 0: 6/2012