Cryogenic Temperature and Epoxies

What Happens to Epoxies at Cryogenic Temperatures?

Exposing epoxy to very low, even cryogenic temperatures, will not cause any degradation of the material, however, some performance properties may change.

Most EPO-TEK® datasheets list -55°C as a minimum operating temperature, but that is due to test equipment limitations, not epoxy constraints. Many epoxies typically will operate well below -55°C; including cryogenic temperatures ranging from -150°C to absolute zero (-273°C).

As temperature decreases, the modulus will increase, and cold epoxies are more brittle than they are at room temperature. Epoxies that perform well at low temperatures tend to be those with lower moduli. When the modulus increase is minimal, it induces less stress on the bonded components as a result of the changes in temperature.

Which Industries Use Epoxies at Cryogenic Temperatures?

Few devices will require this type of low temperature exposure. Industries such as aerospace, satellite components, as well as scanning electron microscopes can require cryogenic epoxies. These specific areas many include: potting, die attach and heat sink attach.

Which EPO-TEK Products Are Best Suited for Use at Cryogenic Temperatures?

- Electrically Conductive Component Attach
  - *Heat Cure:* H20E
  - *Low Stress/Low Temp Cure:* EJ2189, EJ2189-LV, EJ2312
- Thermally Conductive, Potting and Heat Sinking
  - *Low Stress & Rigid:* T7110
  - *Low Stress & Flexible:* T7109-19
- Potting & Protection
  - *Smaller Volumes:* 301-2
  - *Larger Volumes:* 301-2FL, T7110
- General Adhesion
  - *Optical:* 301-2
  - *Thermal:* T7110

Characteristics To Help Choose the Correct EPO-TEK® Product

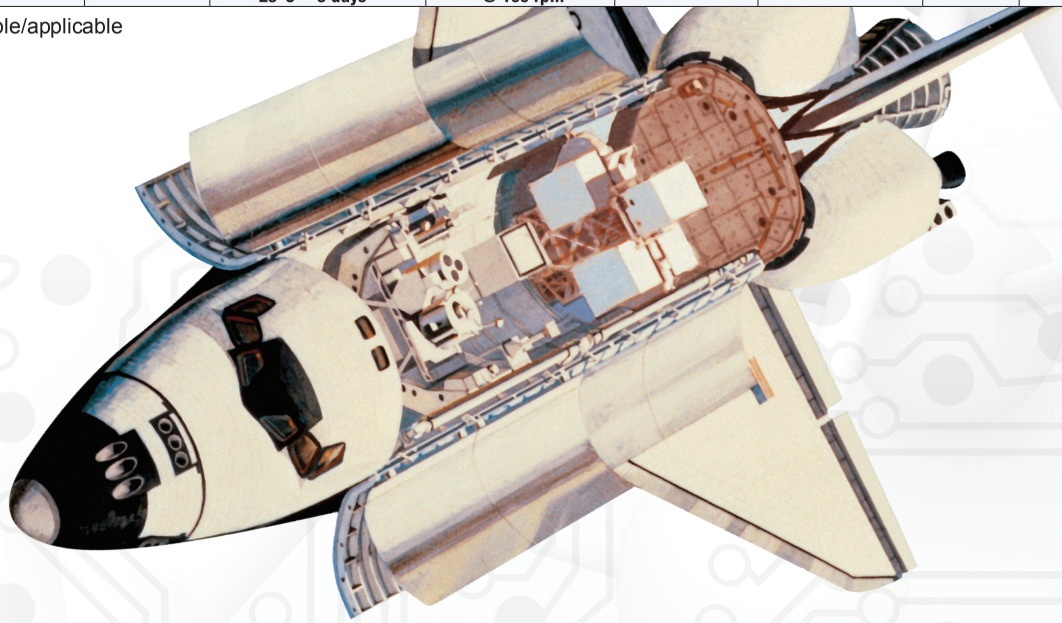
EPO-TEK	Key advantages/ Characteristics
301-2	Clear epoxy, room temp cure, high shear strength at cryo temps, meets NASA low outgassing with heat cure
301-2FL	Lower modulus version of 301-2 for lower stress and larger volume applications
EJ2189	Electrically conductive, room temp cure, high viscosity
EJ2189-LV	Electrically conductive, room temp cure, lower viscosity version of EJ2189
EJ2312	Electrically conductive, room temp cure in 24 hours
H20E	Electrically conductive with high thermal conductivity, meets NASA low outgassing
T7109-19	Thermally conductive, flexible, low temp cure with heat cure options for lower outgassing values
T7110	Thermally conductive, low temp cure, high shear strength at cyro temps. Great for large volume potting, meets NASA low outgassing with heat cure

EPOXY TECHNOLOGY

How Do The EPO-TEK Properties Compare?

EPO-TEK®	NO. of COMPONENTS	COLOR Before/ After CURE (thin film)	CURE TEMPERATURE (minimal)	VISCOSITY @ 23°C	GLASS TRANSITION TEMPERATURE (Tg)	DIE SHEAR STRENGTH @ RT (80mil x 80mil)	INDEX OF REFRACTION (Nd)	SPECTRAL TRANSMISSION	TGA DEGRADATION TEMPERATURE	CTE Below Tg/ Above Tg (in/in/°C)	POT LIFE (@ room temp.)	SHELF LIFE (@ room temp. unless noted)
301-2	Two	Clear/ Colorless	80°C – 3 hours 23°C – 2 days	225 - 425 cPs @ 100 rpm	≥80°C	≥15 kg/5,100 psi	1.5318 (uncured)	≥94% 300nm ≥99% 400-1200nm ≥98% 1200-1600nm	360°C	61 x 10^{-6} 180 x 10^{-6}	8 hours	1 year
301-2FL	Two	Clear/ Colorless	80°C – 3 hours 23°C – 3 days	100 - 200 cPs @ 100 rpm	≥45°C	≥10 kg/3,400 psi	1.5102 (uncured)	≥97% 1000-1600nm ≥99% 400-1000nm	325°C	56 x 10^{-6} 211 x 10^{-6}	10 hours	1 year
EJ2189	Two	Silver/Silver	150°C – 1 hour 23°C – 3 days	55,000 - 90,000 cPs @ 1 rpm	≥30°C	≥9 kg/3,060 psi	N/A	N/A	316°C	53 x 10^{-6} 107 x 10^{-6}	4 hours	1 year
EJ2189-LV	Two	Silver/Silver	150°C – 1 hour 23°C – 3 days	25,000 - 45,000 cPs @ 1 rpm	≥40°C	≥10 kg/3,400 psi	N/A	N/A	340°C	52 x 10^{-6} 89 x 10^{-6}	4 hours	1 year
EJ2312	Two	Silver/Silver	23°C – 24 hours	58,822 cPs @ 1 rpm	45°C	13 kg/4,420 psi	N/A	N/A	329°C	N/A	90 min	1 year
H20E	Two	Silver/Silver	175°C – 45 sec 80°C – 3 hours	2,200 - 3,2000 cPs @ 100 rpm	≥80°C	>10 kg/3,400 psi	N/A	N/A	425°C	31 x 10^{-6} 158 x 10^{-6}	2.5 days	1 year
T7109-19	Two	Grey/Grey	80°C – 2 hours 23°C – 2 days	40,000 - 70,000 cPs @ 5 rpm	≤40°C	>5 kg/1,700 psi	N/A	N/A	338°C	59 x 10^{-6} 216 x 10^{-6}	2 hours	1 year
T7110	Two	Grey/Grey	150°C – 15 min 23°C – 3 days	1,400 - 2,200 cPs @ 100 rpm	≥40°C	≥10 kg/3,400 psi	N/A	N/A	314°C	31 x 10^{-6} 142 x 10^{-6}	3.5 hours	1 year

N/A - not available/applicable



Please consult our *Application Experts* at Epoxy Technology to find the most suitable adhesives for your specific technical challenges at: techserv@epotek.com.

EPOXY TECHNOLOGY

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