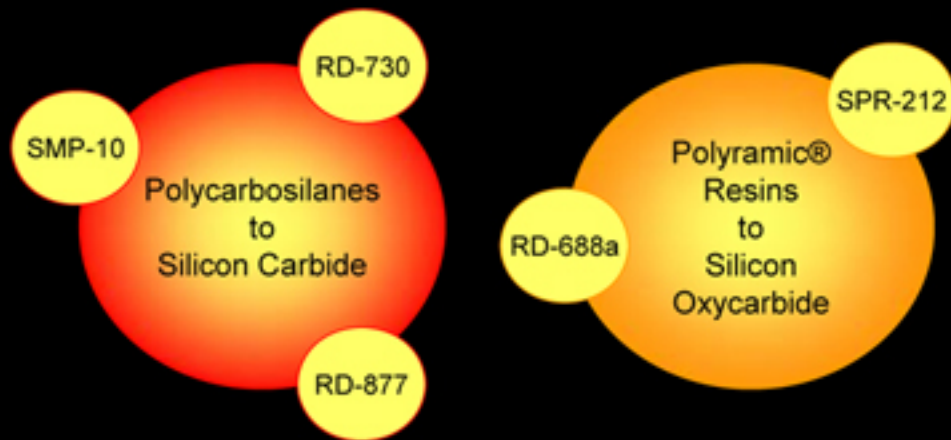


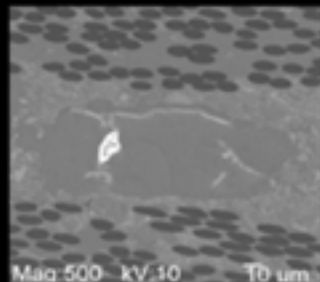
Polymer-to-Ceramic™ Technology from Starfire Systems

Versatile Chemistries

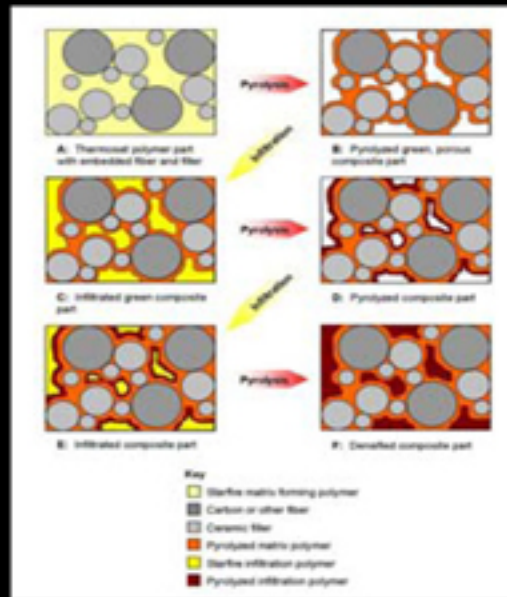


Processing

- Polymers are liquids or low melting point solids.
- Form parts using conventional polymer processing.
- Use polymer infiltration and pyrolysis (PIP) to densify.



C/SiC laminate showing filling of porosity through PIP



- Tailorable density and properties of final parts.

Other Available Forms

- Variety of matrix slurries for ceramic matrix composites (CMCs) with fillers of desirable properties.
- Bulk molding compounds (BMC) with discontinuous carbon fibers, and dry bulk molding compounds for production of monolithic ceramics.
- Polymers can be used to produce protective coatings for high temperature oxidizing environments.

Properties and Applications of Starfire Polymer-to-Ceramic™ Technology

Polymer Properties



SMP-10 with C/SiC brake rotors

Resin	Viscosity (cP)	Pyrolysis yield (%)	Density (g/cm ³)
SMP-10	40 - 100	72 - 78	1.0
RD-730	Solid	65 - 67	1.0
SPR-212	12 - 26	60 - 65	1.0
RD-688a	300 - 2,000	65 - 68	1.1

Properties of preceramic polymer resins from Starfire Systems.

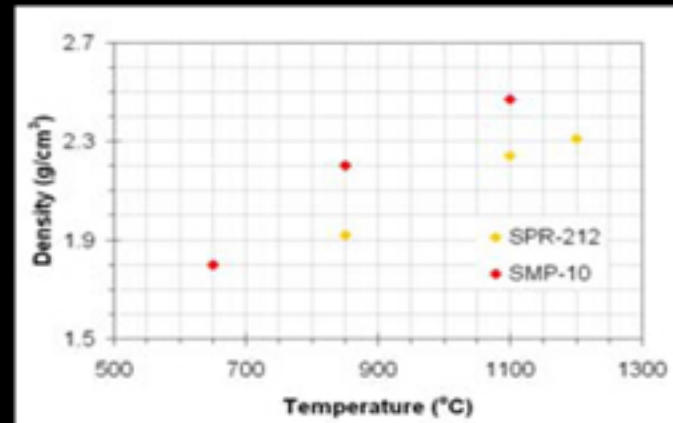


SPR-212 with C/SiC laminate

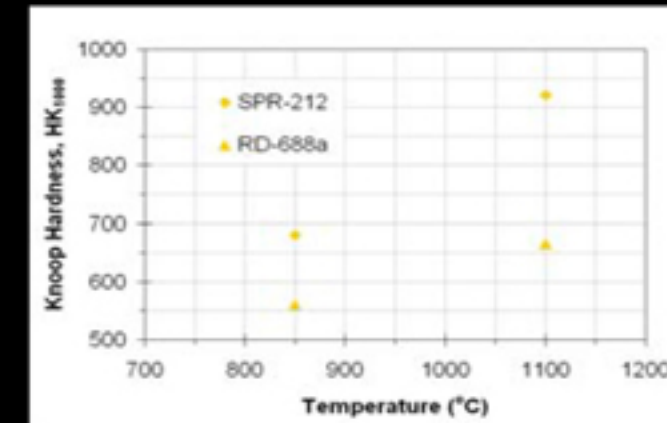


Dry molding compound (RD-396) with a SiC monolithic part fabricated from the same compound.

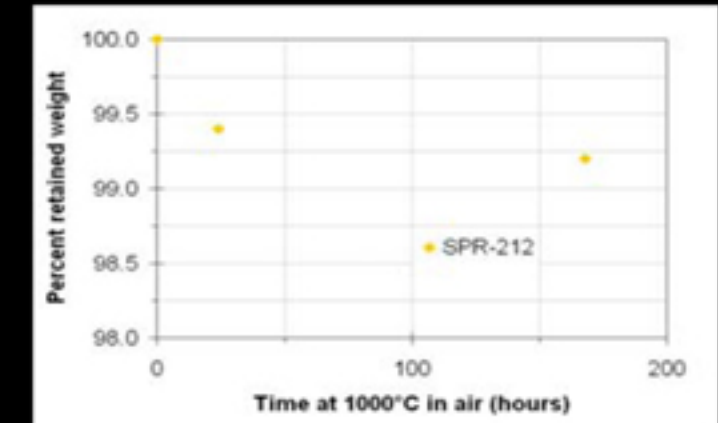
Ceramic Properties



Density by helium pycnometry for SMP-10 and SPR-212 derived ceramics as a function of pyrolysis temperature.



Knoop hardness for SPR-212 and RD-688a derived ceramics as a function of pyrolysis temperature.



Weight retention in air for pyrolyzed SPR-212 at 1000°C.

Pyrolyzed materials are black glassy solids. SPR-212 and SMP-10 retain this appearance even after long term high temperature exposure in air.

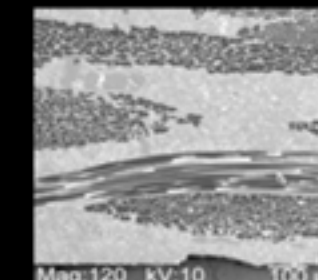


Carbon fiber bulk molding compound (RD-601) with cured and pyrolyzed panels (left and right).

Composite Properties

Matrix resin	Infiltration resin	Flexural strength (MPa)	Flexural modulus (GPa)
SMP-10	SMP-10	249	73.0
RD-688a	SPR-212	240	81.1
SPR-212	SPR-212	255	78.2

Mechanical properties for polymer derived ceramic matrix composites consist of T-300 6K, 5HS carbon fabric, 0,90 orientation, 6mm thick.



C/SiC laminate



Chopped fiber C/SiC Polymer-to-Ceramic Composite (PTCC) automotive brake rotor

