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# Starfire Polymer-to-Ceramic Composite (PTCC) Material Manufacture through Polymer-to-Ceramic™ Technology

## SC-80 Formulation



## Requirements

### ■ Materials

- Starfire Systems' supplied polymer
  - Fabrication polymer (SL products)
  - Reinfiltration polymer

- Reinforcement or Fabric

### ■ Curing Capability; (one or any of the following)

- Hydraulic press capable to reach 200psi
- Vacuum Assisted Resin Transfer Molding (VaRTM, RTM) capability
- Vacuum bag, Autoclave curing capability

### ■ Pyrolysis Capability

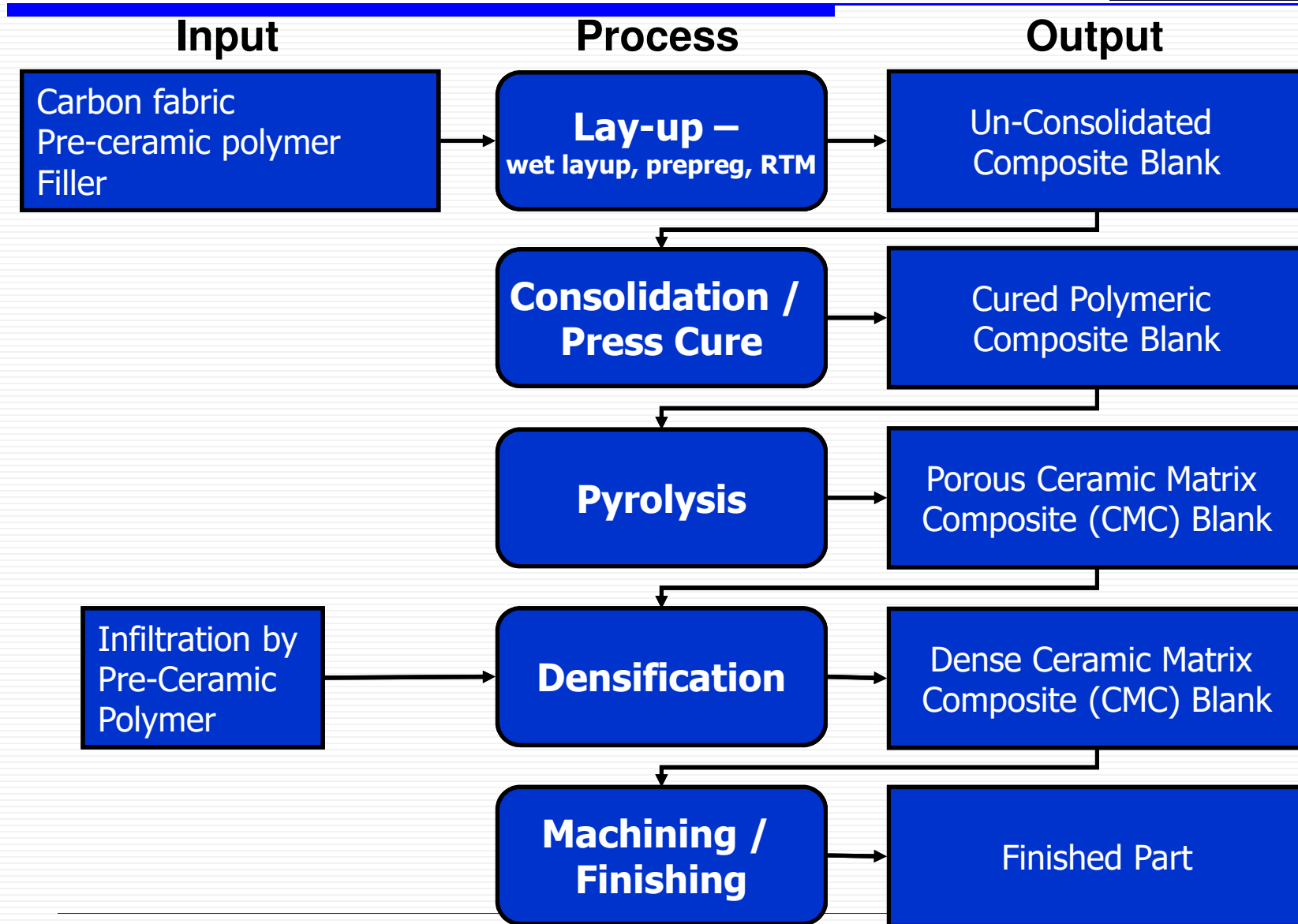
- Inert pyrolysis furnace capable to process 800-1,200C

### ■ Polymer Infusion and Pyrolysis (PIP) Capability

- Vacuum capability to introduce polymer

### ■ Inspection equipment

- Scales, gages



Processing step	Description	Equipment and material requirements
Lay-up	<ul style="list-style-type: none"> <li><input type="checkbox"/> Wet Layup - rolling filled polymer (slurry) onto plies of carbon fabric. Individual plies are stacked to the required thickness and orientation.</li> <li><input type="checkbox"/> Prepreg – Cut pre-coated cloth to size; stacked to the required thickness and orientation.</li> <li><input type="checkbox"/> Resin Transfer Molding (RTM), Vacuum Assisted Resin Transfer Molding (VaRTM)– stack cloth to the required thickness and orientation in RTM tooling. Filled polymer (slurry) or neat polymer is introduced to closed tooling under pressure or vacuum.</li> </ul>	<ul style="list-style-type: none"> <li><input type="checkbox"/> Fabrication polymer or slurry</li> <li><input type="checkbox"/> Reinforcement cloth, or</li> <li><input type="checkbox"/> Prepreg</li>   <li><input type="checkbox"/> RTM tooling</li> </ul>
Consolidation and Cure	<ul style="list-style-type: none"> <li><input type="checkbox"/> Compression mold press cure the stacked impregnated cloth, or</li> <li><input type="checkbox"/> Vacuum bag, autoclave cure the stacked impregnated cloth, or</li> <li><input type="checkbox"/> Cure the RTM'd/VaRTM'd stacked cloth</li> </ul>	<ul style="list-style-type: none"> <li><input type="checkbox"/> Press capable of up to 250°C and up to 300 psi. No atmosphere control is necessary.</li> <li><input type="checkbox"/> Shims to maintain thickness.</li> </ul>

Processing step	Description	Equipment and material requirements
Pyrolysis	<ul style="list-style-type: none"> <li><input type="checkbox"/> Place the cured blank into furnace.</li> <li><input type="checkbox"/> Heat under inert environment, ambient pressure, to maximum pyrolysis temperature.</li> </ul>	<ul style="list-style-type: none"> <li><input type="checkbox"/> Furnace capable of up to 1,200°C at heating/cooling rates between 1 and 5°C per minute in an argon or nitrogen environment, ambient pressure.</li> <li><input type="checkbox"/> Exhaust capability for the furnace capable of venting evolved hydrogen and other volatile effluents.</li> </ul>
Polymer Infiltration and Pyrolysis (PIP)	<ul style="list-style-type: none"> <li><input type="checkbox"/> Place the pyrolyzed blank into vacuum vessel or container, and hold under vacuum.</li> <li><input type="checkbox"/> Introduce polymer into pyrolyzed blank, maintain vacuum.</li> <li><input type="checkbox"/> Release vacuum, hold at ambient pressure</li> <li><input type="checkbox"/> Pyrolyze (see above)</li> <li><input type="checkbox"/> Repeat</li> </ul>	<ul style="list-style-type: none"> <li><input type="checkbox"/> Vacuum infiltration chamber capable of reaching at least &lt;5 torr.</li> <li><input type="checkbox"/> Pyrolysis furnace (see above).</li> </ul>

Processing step	Description	Equipment and material requirements
Machining Surface Grinding Finishing Engraving	<input type="checkbox"/> Dense ceramic blank is machined.	<input type="checkbox"/> Machining and surface grinding capabilities for dense ceramic matrix composite components.
Inspection	<input type="checkbox"/> Inspect the densified ceramic blank	<input type="checkbox"/> Final requirements <input type="checkbox"/> Inspection equipment