Thermosetting injection moulding for shaping of C/C-SiC-ceramics: Influence of flow direction and weld lines

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- Reduction of manufacturing costs of ceramic matrix composites based in C/C-SiC
- automated manufacturing of the CFRP green bodies in the 3-step process route
- injection moulding enables resource-conserving and reproducible production of complex shaped part in high quantity
- just the large-scale and automated production of the CFRP green bodies enable development of mass markets
- compounding and injection moulding shortens the fibres significantly
- the fibre length generate the quasi ductile behaviour of the CMC → increase of the fiber length is absolutely necessary

Shaping (CFRP)  Pyrolysis (C/C)  Silicon infiltration (C/C-SiC)

- Examination of the influence of weld lines, flow directions, fibre orientation on the properties of the CMC
- Use of the flow properties for targeted fibre alignment
- Direct impregnation of textile semi-finished products

IM-LSI process (injection moulding and liquid silicon infiltration)
1. Compounding: mixing phenolic resin and carbon fibres
2. Thermoset injection moulding: cold cylinder, hot mould
3. Ceramisation: Pyrolysis and infiltration with silicon
4. Characterisation: Microstructure and mechanical properties

- Specimen of position 1 has the lowest mechanical properties, fibre orientation is perpendicular to load direction
- Specimen 2 and 3, both have fibres parallel to load direction, specimen of position 3 show the influence of a weld line which results in lower orientation is perpendicular to load direction

Flow direction
- fibres orient themselves perpendicular to the flow direction
- is strongly affected by gate and barriers
- has a great influence on the mechanical properties of the CMC
- flat gate type is recommended and gate position should be perpendicular to main load direction

Weld lines
- become visible through microstructure analysis
- obvious negative influence on bending strength (see diagram)
- should be avoided as in plastic components or placed in less stressed areas

Left: Schematic illustration of component filling and specimen removal
Right: Real flow lines and fibre orientation within the specimen positions

Comparison of the mechanical properties of the three positions

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