Manufacturing and Design of nonoxide Ceramic Matrix Composites for Gas Turbine Applications

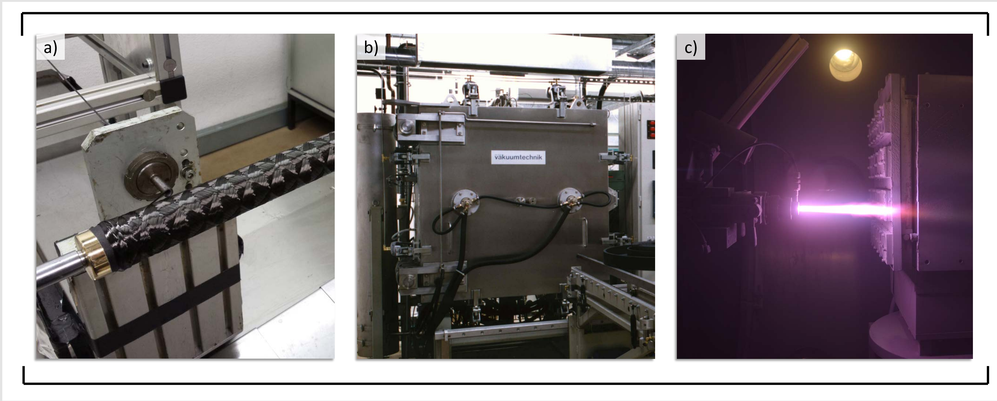
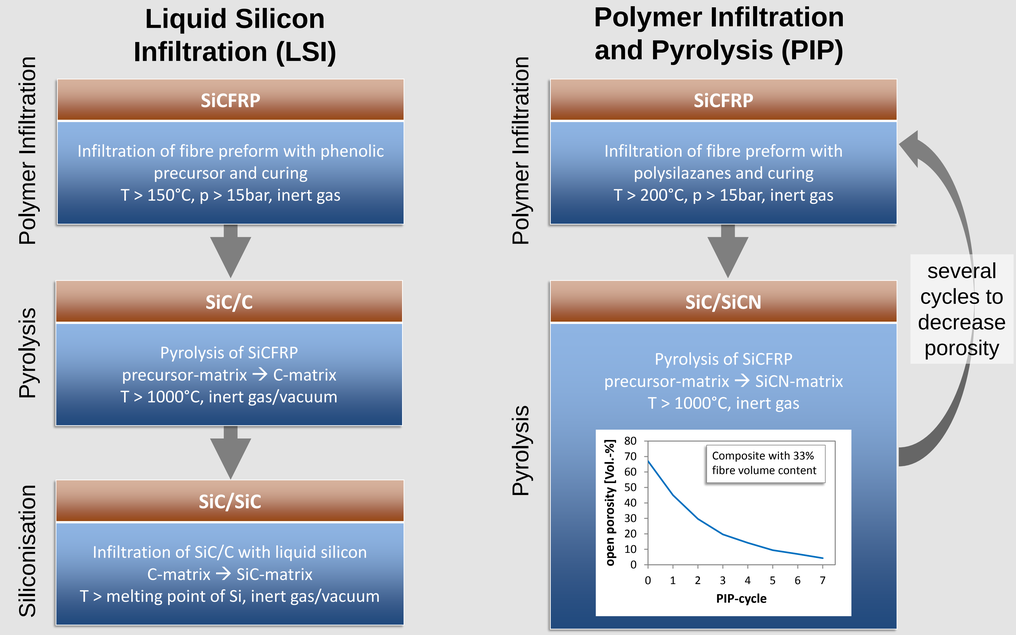


Fig. 1: Different techniques to manufacture nonoxide CMCs at DLR: a) filament winding process; b) furnace for pyrolysis and siliconisation; c) plasma spraying of environmental barrier coatings on CMCs

- SiC/SiC(N) composites show good thermal shock resistance, a low coefficient of thermal expansion and excellent physical and chemical stability at elevated temperatures and are therefore promising candidates for various applications in gas turbines
- Liquid silicon infiltration (LSI) is a technique with short process times to obtain composites with low porosity. In this 3-step process, a phenolic resin based carbon precursor is infiltrated in fibre preforms and thermally cured and pyrolysed. Liquid silicon infiltration leads to a reaction of the carbon matrix with silicon to silicon carbide
- To protect the SiC fibre from attack of the melt and to simultaneously create a damage tolerant crack behaviour, a functional fibre coating is crucial. Fig. 3a shows such a coating consisting of Si-doped BN as inner layer and SiC as outer layer
- Polymer Infiltration and Pyrolysis (PIP) is another technique characterised by infiltrating and curing a silicon-organic precursor and afterwards converting the precursor to a ceramic matrix by pyrolysis. Due to an occurring shrinkage of the precursor during pyrolysis, this process has to be repeated several times to decrease the porosity
- To improve the oxidation resistance, a plasma sprayed yttrium silicate environmental barrier coating is under development (Fig. 1c)



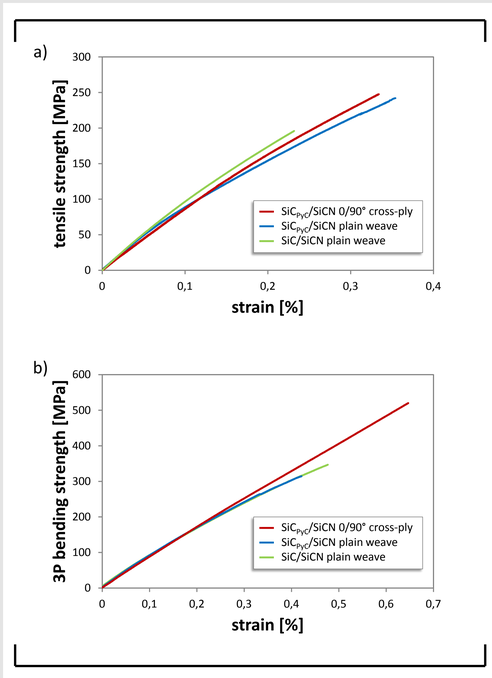


Fig. 2: mechanical properties of PIP SiC/SiCN composites based on the Tyranno SA3 fibres with 33% fibre volume content at room temperature: a) tensile strength;
b) bending strength via 3PB-test

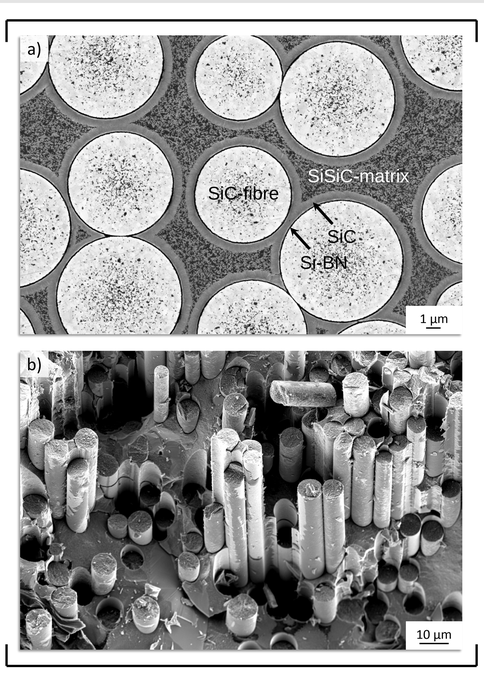


Fig. 3: SEM micrographs of composites manufactured via LSI-Process: a) polished cross section shows Si-BN/SiC coated fibres embedded in a nano-sized SiSiC matrix;
b) fractured surface shows fibre pullout

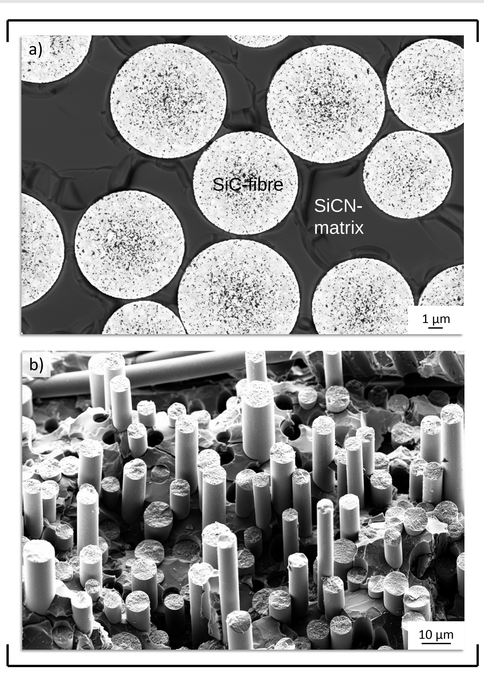


Fig. 4: SEM micrographs of composites manufactured via PIP-Process: a) polished cross section shows the typical dense and shell-like structure of the amorphous SiCN matrix; b) fractured surface shows fibre pullout

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