Silicon carbide (SiC) based ceramics are interesting materials for high temperature structural applications due to mainly its high strength and low oxidation rate in high temperature and good heat emissivity. To provide strength and toughness, continuous fiber reinforced SiC composites are being developed. Thus the thermomechanical properties of SiC/SiC can be improved over that of monolithic SiC.

The SiC-SiC composite were obtained by conversion reactions at high temperatures and controlled atmosphere (CVR process), from a porous carbon-carbon composite precursor. The fabrication of carbon-carbon composite, arranged in 8 layers of carbonized fiber woven, included the manual impregnation with phenolic resin, Resafen 8121, manufactured by Resana Ltda. Each layer was put upon the previous in the same orientation. The laminated was molded in autoclave, with application of pressure of 0.3 MPa in the temperature of 130°C, at a rating hate of 5°C.min⁻¹. The composite was carbonized at 1000°C in atmosphere of argon.

After the carbonization, the carbon-carbon composite was covered by a powder mixture of 60SiC-20Si-10Al₂O₃ wt% and packed in a graphite crucible. The graphite with the sample powder mixture was dried for 16 h at 200°C and heat treated for 3h varying temperature between 1400°C to 1800°C, in a argon flow of 100 ml/min in a tubular graphite furnace.

The conversion occurs by the formation of a reactive SiO gas generated by the reaction between the ceramic components of the mixture. The SiO gas in contact with carbon of the composite reacts forming of SiC. The conversion level was measured by mass change in air oxidation of the CVR converted SiC-SiC composite by thermogravimetric analysis and the microstrutural features and phase analysis was performed by SEM and X-ray diffraction.

Figure 1a shows that the conversion was incomplete at the temperature of 1400°C/3h. Only the surfaces of the fiber and carbon matrix were converted. At 1600°C/3h (Figure 1b), the fibers and the matrix are totally converted in two phases of β-SiC, Figure 2. The major phase present is a cubic β-SiC with minor percent of hexagonal β-SiC. At 1800°C (Figure 1c), the SiC grains growth and broken the fiber with a loss of the fiber integrity and its reinforcement characteristics.

The complete conversion at 1600°C/3h can be proved by TGA analysis, Figure 3. The weight change by oxidation show a mass gain by SiO₂ formation due to SiC oxidation.
Figure 1: Microstructural analysis of SiC-SiC converted, using CVR technique, BSE image; (a) Formation of β-SiC only on the surface of Carbon (1400°C/3h), the dark regions are related to C/C and the bright regions are related to SiC regions; (b) Conversion of β-SiC fibers and matrix (1600°C/3h); (c) Conversion of β-SiC with degradation of fibers (1800°C/3h).

Figure 2: XRD pattern of SiC converted at 1600°C/3h.

Figure 3: Mass gain due to formation of SiO₂ in oxidation at 1000°C.

REFERENCES

