High temperature oxidation behaviour of a hot isostatically pressed silicon nitride-titanium diboride ceramic composite

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Hot isostatic pressing has allowed the production of a dense electroconductive silicon nitride-35vol% titanium diboride composite at a temperature which restrains the decomposition of silicon nitride and the reaction between the two powders. Indeed above 1710°C, the formation of silicon, titanium nitride and boron nitride has been observed and proved by X-Ray diffraction analysis.
Nevertheless, a very low amount of additives (0.5wt%Y_2O_3 and 0.25wt%Al_2O_3) are necessary to achieve good densification without decomposition below 1725°C.
The oxidation mechanism of this dense composite material is analysed.
The composite starts to oxidize at about 700°C where titanium diboride TiB_2 forms rutile and boron sesquioxide B_2O_3.Then, oxidation tests were conducted in flowing oxygen between 900 and 1400°C for 24 hours (Fig. 1). Up to 1300°C, the weight gains are low (less than 1mg/cm^2) and the behaviour may be related to the formation of rutile together with the B_2O_3 evaporation.
The external oxide scale is thin but a subscale is noticed with titanium depletion.
At 1350°C and 1400°C (Fig. 2 and 3), the cristobalite phase is no more observed but there is formation of a fluid borosilicate which embedds the rutile crystals formed during the first hours. The linearity of the kinetics after five hours allows to conclude at a reaction regime. Y-Ti-O-Si needles and platelets on the surface confirms the migration of yttrium through grain boundaries.
This material is more oxidation resistant than a similar hiped silicon nitride – 35 vol% titanium nitride composite elaborated without additive.

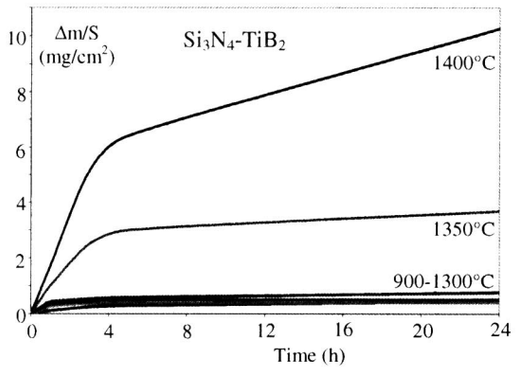
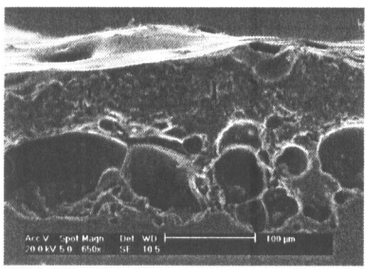
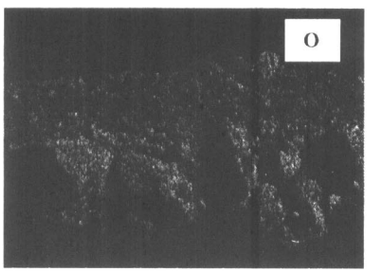
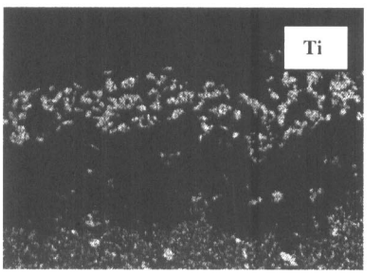


Fig. 1. Isothermal oxidation curves.







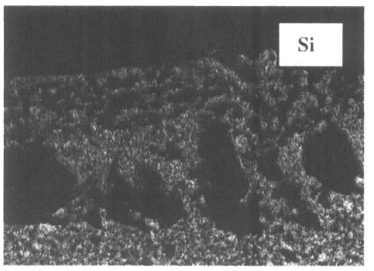


Fig. 2. Oxidation at 1400°C, 5 h., O_2.

Fig. 3. EDS analysis.