

Ceramic composites derived from polysiloxane/Al/Nb by AFCOP process

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Abstract. In this work, ceramic matrix composites (CMC) were prepared by AFCOP process, using a polysiloxane network filled with metallic niobium and aluminum powders as active fillers. The liquid polysiloxane precursor was loaded with a suitable polymer/filler ratio with respect to stoichiometric Nb : C and Al : O molar ratios. Changing Al by α -Al₂O₃, which acted as inert filler, non-stoichiometric conditions were obtained. The mixtures were blended, uniaxially warm pressed, and pyrolysed in flowing argon at 800, 1000 and 1200 °C. Thermogravimetry was used to follow the weight changes during the pyrolysis process. X-ray diffraction was used to identify the formation of new crystalline phases, such as Al₂O₃, NbC, Nb₂C and Al₃Nb in the composites. Sintered specimens were also characterized by SEM and EDS. The results have indicated a good potential of this system to obtain multiphasic composite material in the Al-Nb system at lower temperatures.

Introduction

Polymer pyrolysis is a relatively new and very promising technique for processing of advanced ceramics in complex shapes [1]. The main advantages of such polymer-derived ceramics are the applicability of polymer-processing techniques, the homogeneity of the precursors on a molecular level, the low processing temperatures when compared to conventional powder sintering methods, and the possibility of synthesizing new compounds [2].

Ceramic preparation via active-filler-controlled polymer pyrolysis (AFCOP) has been studied in a broad range of multicomponent systems [3], as a promising technique for the preparation of monolithic ceramics. In this approach, ceramic or metallic powders are introduced into a preceramic polymer, which act as a preceramic binder during the processing of the green body, and as a ceramic matrix source at higher temperatures [4]. Employing reactive filler particles, the reactions of these particles and the decomposition products of the polymeric phase or the reactive gas atmosphere promote a volume expansion. Consequently, near-net shaped crack-free composites can be achieved, due to the compensation of the polymer shrinkage by the appropriate filler expansion [3].

Composites derived from Nb/Al₂O₃-filled polysiloxane have already been studied [5], by using a poly(methylsiloxane) filled with 40 vol.% of a mixture of metallic niobium (reactive filler) and alumina (inert filler), which was pyrolysed in inert atmosphere up to 1450 °C. The *in situ* formation of NbC led to a material with high hardness and wear resistance. However, the metallic niobium can also be oxidized leading to niobium oxycarbide, NbO_xC_y, as well as niobium oxide, which weaken the resulting composites.

The results presented in this article are a first step in understanding the role of metallic aluminum in preventing Nb oxidation and also in generating an *in situ* ceramic phase of Al₂O₃, with concomitant formation of SiC and NbC crystalline phases, during the pyrolysis of filled-polysiloxane.

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