FABRICATION OF NEAR NET-SHAPED ALKALINE-EARTH-BEARING CERAMICS

BY THE OXIDATION OF SOLID, METAL-BEARING PRECURSORS

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Abstract

Alkaline earth (AE)-bearing ceramic compounds have attractive thermochemical and/or electromagnetic properties for a number of technical applications. A novel and attractive method for fabricating near net-shaped, AE-bearing ceramics is the oxidation of solid, AE-metal-bearing precursors. AE metals (Mg, Ca, Sr, Ba) are relatively ductile, so that AE-bearing precursors can be compacted to relatively high green densities and then formed into desired shapes by deformation processing or machining. Alternately, liquid AE metals can be infiltrated into porous oxide preforms. Like organic binders, these malleable AE metals can be completely consumed at a rapid rate by oxidation at \( \leq 500^\circ C \). However, unlike organic materials, these metallic "binders" are retained upon oxidation and can react with other metals and oxides in the precursor during post-oxidation annealing to form ceramic compounds at modest temperatures. The net-shape feature of this process is derived from the fact that most AE metals possess larger molar volumes than the corresponding AE oxides: e.g., \( V_m(Ba) > V_m(BaO_2) \). The opposite is true for other elements: e.g., \( V_m(Si) < V_m(SiO_2) \). As a result, the phase content of AE-metal-bearing precursors can be tailored so as to yield ceramic parts that retain the shape and dimensions of the precursor upon complete transformation. In this paper, work on the fabrication of two electronic ceramics (Nd\(_2\)O\(_3\)-doped BaCeO\(_3\) and Sb\(_2\)O\(_3\)-doped (Ba,Pb)TiO\(_3\)) and two refractory ceramics (BaAl\(_2\)Si\(_2\)O\(_8\) and MgAl\(_2\)O\(_4\)) is discussed.

Key words: Fabrication, near net-shaped, alkaline earth(AE)-bearing ceramics, oxidation