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MECHANICAL PROPERTIES OF CONSOLIDATED NANO-SIZED ALPHA ALUMINA POWDER TREATED WITH BOEHMITE GEL AS A BINDER

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ABSTRACT

Ceramic fabrication processes like injection molding, extrusion process, gel casting etc. inevitably use binder to improve the green strength of the ceramic body. Therefore, the choice of appropriate binder and its optimum quantity is the most important aspect for ceramic fabrication. There are many binders which can be used like polyvinyl alcohol, starch, methyl cellulose, dextrin, poly ethyl glycol, kaolin, ball clay, bentonite etc. PVA (polyvinyl alcohol) is mostly used binder but due some disadvantages (often leads to pores, micro cracks and in some cases charred carbon residue in the structure) we were opting for a possible substitution of PVA. In this work, sol gel derived alumina gel or boehmite (AlO(OH)) was added as binder to consolidate alpha alumina powder as a potential alternative to commonly used polyvinyl alcohol (PVA). Commercial Alpha alumina powder with small amount of grain growth inhibitor (MgO) was milled for 10 hours at 250 rpm using zirconia bowl and balls. Milled powder slurry was dried and crushed to powder in a morter pestle. The particle size distribution and the surface roughness of commercial alpha alumina powder and that of the crushed powder samples were characterized by atomic force microscopy. AFM study showed that the mean size of alpha alumina has reduced from 218 nm to 98 nm after 8 hours of milling. Alumina gel was made by Yoldas process. Pallets fabricated with commercial alpha alumina and also with milled alpha alumina are treated with PVA as well as alumina gel differently. The green consolidated alpha alumina in the pallet forms was sintered at 16000C for 8 hours. The residual porosity of consolidated fine powders with bohemite gel as binder was evaluated as low as 5%. The Vickers hardness, tested under load range from 5Kg to 30Kg belong to the range of 1315Kgf/mm2 to 1148Kgf/mm2 and the indentation fracture toughness, measured as a function of crack type (Palmqvist or median) showed variation ranging from 3.2MPa√m to 5.43MPa√m.

Keywords: Alumina, Boehmie, Binder, Hardness, Fracture toughness