Gelcasting of Alumina Slurry with Additions of Polyacrylamide and Plasticizer

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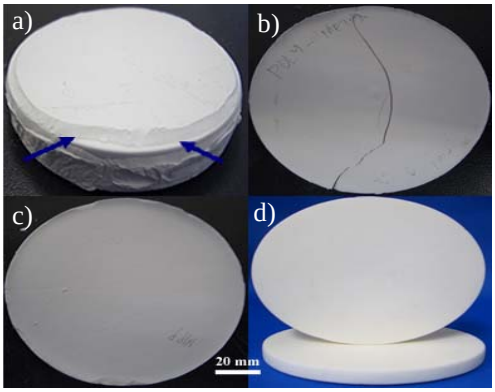
Introduction

In gelcasting by use of ordinary formulation of monomers, several limitations are encountered such as inhibition of gelation in the presence of oxygen, cracking during drying and sintering steps, and others. Many reports have successfully resolved each issue, but none of them addressed all limitations in single slurry. In the fabrication of large ceramics, particularly large alumina sheets, it is desirable that the mentioned limitations are addressed in single slurry so that it is capable to gelcast under normal condition without careful control.

In this study, therefore, the conventional gelcasting slurry consisting of alumina, methacrylamide (*MAM*) and long-chain cross-linker (*PEGDMA*) is treated with both polyacrylamide and plasticizer (*PEG400*), in an attempt to address some of the aforementioned issues.

Methods

Alumina (AL 160SG-4, D_{50}= 0.45 μm) was dispersed in distilled water with the aid of dispersant (Seruna D-305, 40% solution). Three slurry formulations were prepared and rheologically analyzed for comparative evaluation. The slurries were gelled at 25°C with Ammonium peroxodisultate as initiator and N,N,N',N'-Tetramethylethylenediamine as catalyst. The gelled bodies were demolded, wrapped with wet paper and laid on plastic screen, and dried for one week under room conditions, followed by oven drying to constant weight. Then, thermal analysis was conducted. Samples were debindered at 700°C for 2 hrs., followed by sintering at 1600°C.



Gelcasted samples with additions of: (a) only plasticizer, (b) only polyacrylamide, and (c) both plasticizer and polyacrylamide, and (d) sintered a and c.

Results and Discussion

Rheological analysis revealed a strong shear thinning behavior for all slurries. They strongly fitted the Herschel-Bulkley model with a parameter n<1. The additions of both plasticizer and polyacrylamide into conventional gelcasting slurry did not hinder the fluidity for casting. Based on thermal analysis, the presence of polyacrylamide and plasticizer facilitates binder removal due to formation of long-chain polymer gel network with long-chain cross-linker. The DTA analysis revealed an increasing exothermic peaks from

sample (a) to (c) at about T=363^{o}C. Sample (a) shows surface exfoliation due to inhibition by oxygen. The surface exfoliation was completely eliminated by the addition of polyacrylamide but prone to cracking (b). Despite of the use of long-chain crosslinker to produce gel with long polymer chain, the green body is still rigid due to more hydrogen bonding sites attributed to polyacrylamide. The number of hydrogen bonding was minimized by the addition of plasticizer (*PEG 400*), and the sample dried successfully without cracks (c.). Photograph (d) illustrates the crack-free sintered samples of (a) and (c) in large dimensions (*D=100mm, T=11mm*). The flexural strength for sample (a), (b), and (c), was 349.3, 371.3, and 389.5 MPa, respectively.

Biographical Profile

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