Slip Casting of High Surface Area Alumina using Polyacrylic acid: Effects of Dispersant Concentration, pH, Interparticle Potential Calculations and Rheologocal Behaviour

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The promise of nanograined materials with new properties has led to a great deal of research activity over recent years [1]. When trying to achieve full density grain growth out of the nanoregime (100nm) is often difficult to avoid [2] and microstructures are no finer than traditional sub-micron processed ceramics. Nanopowders are invariably made up of agglomerates 10-20 times larger than the primary nanoparticle and one major factor in the densification of nanopowder compacts is to stimulate inter-agglomerate densification and limit grain growth. In this study we have investigated the properties of colloidal dispersions of a nanosized transition alumina (γ-Al_2O_3). Ceramic forming methods using colloidal suspensions can help improve green microstructures by minimising the number of agglomerates, increasing the packing uniformity, and lowering the average pore sizes [3]. To avoid agglomeration during slip casting most of the dispersions used are stabilized either by electrostatic repulsion or steric hindrance. A particularly efficient way of stabilising alumina suspensions is by the adsorption of a polyelectrolyte such as polyacrylic acid (PAA) which combines both repulsion mechanisms - electrosteric stabilisation [4]. The degree of dispersion of such powders also has a significant influence on the rheology of the slip and consequently on the consolidation kinetics.

Previous studies is focused on the role of polyacrylic acid in slip casting of gamma alumina suspensions. Two pH regimes (pH = 6 and 10)were investigated. At pH 6 the surface of the alumina is positively charged and the PAA totally dissociated which should lead to a "pancake" type of adsorbed layer [5]. At pH 10 the alumina surface is negatively charged and the conformation at the surface is expected to be more "brush"-like.The amount of PAA adsorbed at the different pH's was investigated and adsorption isotherms collected. For the slip casting experiments the amount of PAA in the dispersion was varied from 1-6%wt and the highest green densities were achieved with 6% wt solutions at pH 6 a somewhat unexpected result. The variation in zeta potential, green density, PAA adsorption isotherms and its conformation in conjunction with some preliminary interparticle potential calculations [6], will be discussed to help elucidate this somewhat unexpected behaviour. Comparison with the rheological behaviour of the slips with respect to a proposed stabilization mechanism will also be presented.

References

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