Name (Title):
Yoshio Sakka (Director)
Affiliation:
Nano Ceramics Center
NIMS
Address:
1-2-1 Sengen, Tsukuba, Ibaraki 305-0047, Japan
Home Page: http://www.nims.go.jp/jpn/about/org/field02.html

Lecture Title:
Fabrication of highly microstructure controlled ceramics by novel colloidal processing

Abstract:

In the processing of ceramics by sintering, fine particles are desired not only to reduce the sintering temperature, but also to obtain fine-grained microstructures. However, fine particles will spontaneously agglomerate due to van der Waals forces, to an extent that depends on their processing history. When the agglomerated particles are used, wide variations in pores size distributions are inevitably introduced into the green compact resulting in inhomogeneous microstructures. Colloidal processing is a powerful method for consolidating fine particle with high density and homogeneous microstructure.[1)] The key point is to use non-heavily agglomerate particle and stabilize the each particle in suspension. Usually the particles are dispersed by using the electrostatic repulsive force and/or steric stabilization. In two or more component systems, either of well-dispersed suspension or hetero-coagulated suspension is used.[3),4)] In case of the dispersed suspension of multi-component systems, segregation during colloidal filtration is a common problem due to differences in sedimentation rate but can be minimized by using a suspension with high solid content.

At first I show superplastic zirconia polycrystals as a demonstration of merit of colloidal processing using sub-micron sized commercial powders (Fig. 1). Then I introduce fabrication of dense nano-sized zirconia by the following method without pressure sintering; (1) pressure filtration directly of zirconia sols without the powdering step and low-temperature sintering, (2) pressure filtration of Cu modified zirconia suspension and liquid-phase sintering (3) slip casting using nao-sized zirconia particles and their composites, and low-temperature sintering. Nextly I demonstrate fabrication of porous ceramics with controlled pore size by hetero-coagulated suspension of ceramics and polymer [2)]. Fig. 2 shows schematic procedure. In this case the pore size and porosity could be easily tailored by varying the polymer size and the volume ration of polymer/ceramic particles. Finally I show the colloidal processing, such as slip casting and electrophoretic deposition, under external magnetic field to obtain textured

ceramics with feeble magnetic susceptibility[3,4]. The degree of orientation depends on the processing factors, such as heating temperature, particle size, applied magnetic field, concentration of the suspension, etc. Fig. 3 shows a typical example of textured laminated alumina. This process technique confers several advantages and it is possible for this type of processing to be applied to many non-cubic ceramics.

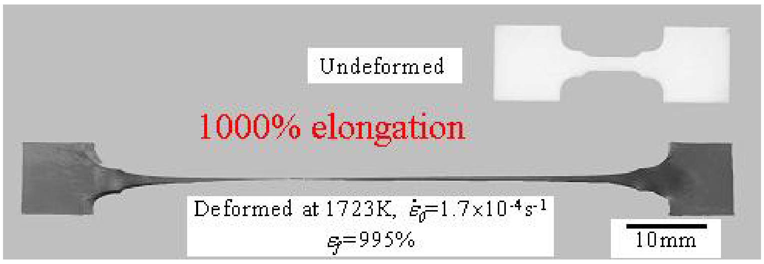

Fig. 1 Superplastic 0.3vol%Al_2O_3 dispesed ZrO2

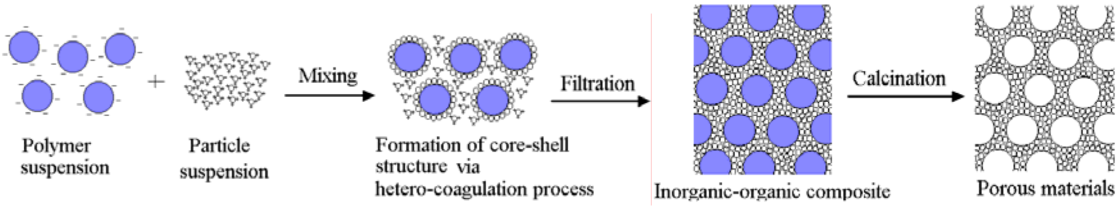

Fig. 2 Schematic procedure for the fabrication of macroporous materials via core-shell flocculation of polymer spheres and inorganic particles.

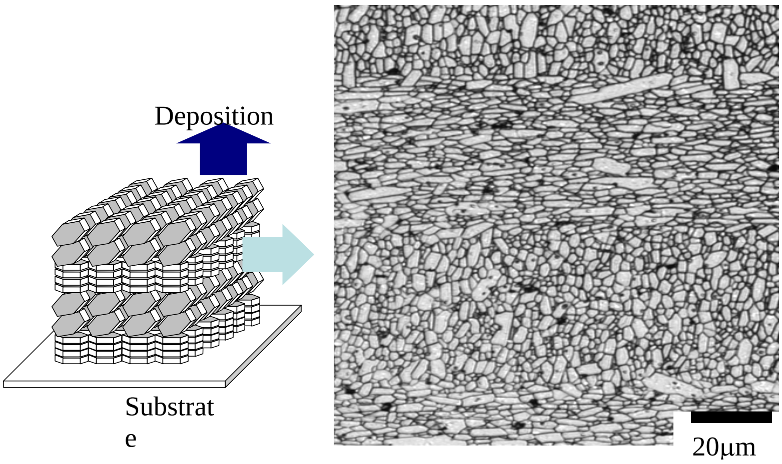

Fig. 3 Designing a crystalline-textured alumina/alumina laminated composite using electrophoretic deposition in a strong magnetic field.

(References ;)
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3) Sakka,Y. and Suzuki, T. S., *J. Ceram. Soc. Jpn.*, Vol.113, pp.26-36 (2005).
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