Control of crystallographic orientation in bulk ceramics by colloidal processing in a high magnetic field

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Tailoring the crystallographic orientation in ceramics is very useful for improving their properties. Many researchers have reported that the textured ceramics were produced by the Templated Grain Growth method (TGG), hot forging, one directional extrusion, etc. In this presentation, a magnetic field is shown to be very effective in controlling the crystallographic orientation in bulk ceramics. We reported that the colloidal processing in a strong magnetic field was able to control the crystallographic orientation even in diamagnetic ceramics. In this process, a strong magnetic field is applied to the particles in a stable suspension. The particles were rotated to an angle minimizing the system energy by a magnetic torque generated from the interaction between the magnetic anisotropy and the applied magnetic field. In this processing, dispersion of powders in a suspension is necessary to effective work of a magnetic field, because large interaction between the agglomerated particles restrains the powder in a suspension from rotating by a magnetic field. Colloidal processing was used for particle dispersion in this study because of developing for consolidating fine particles to avoid heterogeneous agglomerates by electrostatic repulsion due to surface charge.

In the case of Al_2O_3, SiC and $LiCoO_2$, the *c*-axis of hexagonal crystal structure aligned parallel to the magnetic field. The thermal conductivity parallel to the *c*-axis was higher than that perpendicular to the c-axis in textured SiC. In the case of AlN, ZnO and Si_3N_4, we confirmed that the *a*-axis aligned parallel to the magnetic field. The rotating magnetic field was used to control the development of the *c*-axis orientation in order to improve the thermal conductivity.

If the orientation axes of platelet particles aligned due to a geometrical effect and a magnetic field are different, the multi-dimensional orientation can be controlled by simultaneous use of both the effects, and control of the elaborate microstructure will be expected. Figure 1 shows that the pole figure in $Bi_4Ti_3O_{12}$ prepared by slip casting in a magnetic field with platelet particles. The {001} pole figure on T plane perpendicular to the casting direction and parallel to the magnetic field shows a very strong spot at the center, which indicates that the *c*-axis was aligned parallel to the casting direction. The {100} pole figure exhibits a couple of strong spots at the points of 90° from the center along the latitude line. The <100> texture was aligned parallel to the magnetic field. Since the *c*-axis and the <100> axis orientation can be simultaneously controlled.

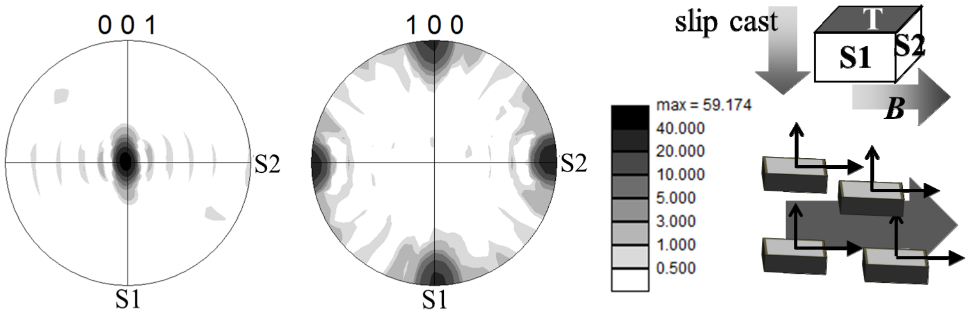

Fig. 1 Pole figure on T plane perpendicular to the slip casting direction in $Bi_4Ti_3O_{12}$ prepared by slip casting in a magnetic field with platelet particles.

Reference

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