Texture Development in Piezoelectric Ceramics by Templated Grain Growth using Heterotemplates

Toshio Kimura, Yoshiyuki Sakuma, and Masatoshi Murata
Graduate School of Science and Technology, Keio University
3-14-1 Hiyoshi, Kohoku-ku, Yokohama 223-852 Japan

Properties of ferroelectric and piezoelectric ceramics are enhanced by the development of crystallographic texture. The templated grain growth (TGG) method is one of the techniques to develop texture in ceramics, and has been applied to the compounds with the perovskite and tungsten bronze structures and belonging to bismuth layer-structured ferroelectrics (BLSF). In this method, a mixture of equiaxed particles (matrix) and particles with shape anisotropy (template) is sintered to develop texture. The templates have been limited to the compounds with the same composition or a least the same crystal structure as the matrix. We found that platelike $Ba_6Ti_{17}O_{40}$ particles acted as templates for the texture formation in $BaTiO_3$, $Pb(Zr,Ti)O_3$, and $BaBi_4Ti_4O_{15}$. This study deals with the mechanisms of texture development by examining the texture and microstructure development in the BLSF matrix using BLSF heterotemplate.

Platelike BLSF particles were prepared by the molten salt synthesis. Matrix particles were prepared by a conventional solid-state reaction. The slurries containing matrix and template particles were tape-cast and the obtained sheets were laminated to prepare green compacts, which were sintered under desired conditions. Crystalline phases and the degree of orientation were determined by X-ray diffraction analysis, and the microstructure was observed with a scanning electron microscopy.

The $Bi_4Ti_3O_{12}$ (BiT) and $BaBi_4Ti_4O_{15}$ (BBT) templates gave extensive <001>-texture in the $SrBi_4Ti_4O_{15}$ (SBT) matrix. The texture developed in the BiT- and BBT-matrix but the degree of orientation was small. The mechanism of extensive texture development was the formation and growth of layers of matrix grains on the template grains. Therefore, the reduction in the grain growth rate hindered the texture development. Another mechanism of texture development was found to be the formation of face-to-face contact between platelike template grains and matrix grains grown to be platelike.