

# Ceramic Processing of Template-Induced Microstructure Textured Ceramics

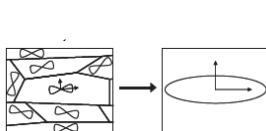
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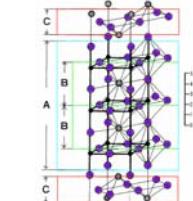
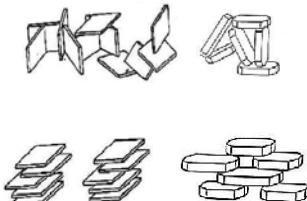
**Abstract** – The target of this work is to develop an advanced manufacturing process that results in a bulk polycrystalline electroceramic component through a texture induced forming method. The technique produces a bulk ceramic component that exhibits enhanced macroscopic properties when compared to a traditional electroceramic. Templatized texturing can involve the “laying down” of seed crystals with planar morphology to induce preferential grain growth within a pre-designed orientation of the bulk ceramic. Through well-controlled slurry processing of ceramic powders and the addition of templated crystals it is possible to induce this preferential grain orientation for sintered ceramics. This work will present the results of a comparison between two separate advanced ceramic forming techniques: tape casting and thick film screen printing, by examining the degree of microstructure texture developed by these methods.

## Background – Textured Ceramic Microstructures

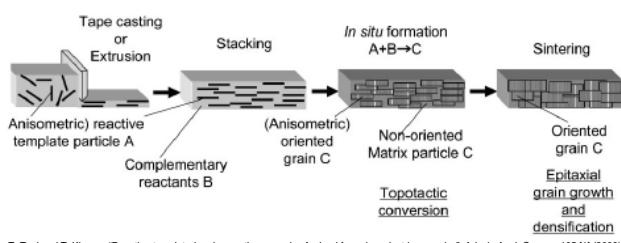
•Templated grain growth (TGG) or reactive templated grain growth (RTGG) can be used to produce preferably oriented polycrystals.



J.L. Jones, "Texture and Anisotropy of Polycrystalline Piezoelectrics", JACERS, 90 [8] 2297-2314 (2007)

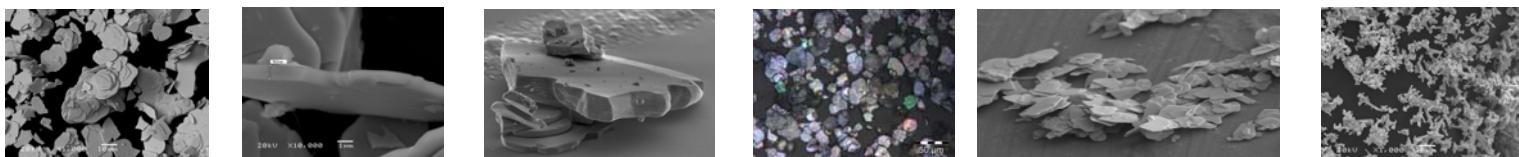


Takenaka, T., JJAP, 19 (1) 31-39 (1980)



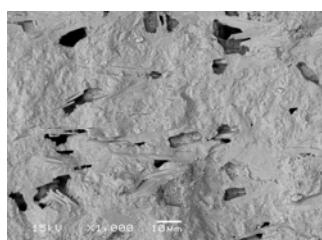
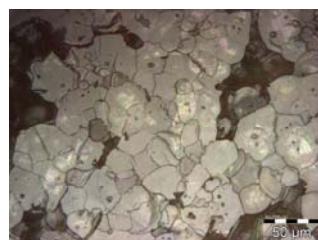
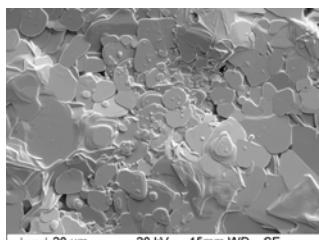
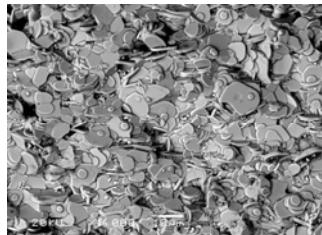
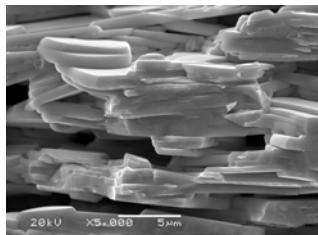
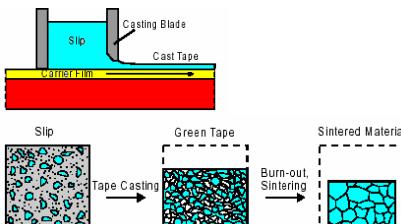
T. Tani and T. Kimura, "Reactive-templated grain growth processing for lead free piezoelectric ceramics", Adv. in Appl. Ceram., 105 [1] (2006)

•Anisometric “template” particles are synthesized in a fused salt synthesis technique.



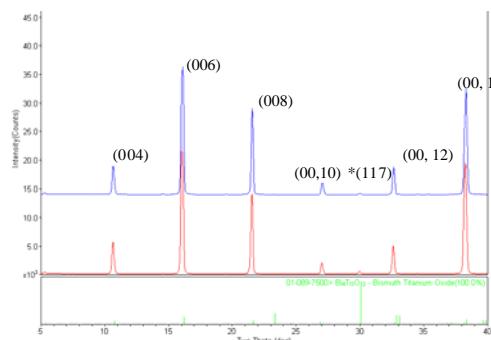
## Forming - Tape Casting and Screen Printing

•The texture development in the bulk ceramic will be accomplished through a fabrication technique that imparts highly-localized shear – resulting in alignment of the template particles in the preferred stress direction.

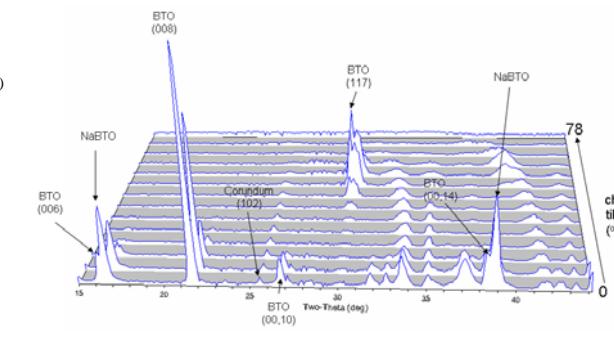


## Analysis – Textured Microstructure Characterization

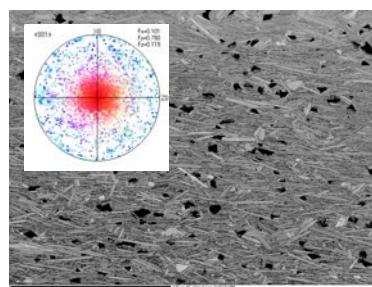
•Textured microstructures from each of the synthesis/forming processes are verified through an x-ray diffraction  $\theta$ - $2\theta$  scan (including pole figures and rocking curves) and electron back scatter diffraction analysis



X-ray diffraction  $\theta$ - $2\theta$  scan for BTO tape cast components, indicating the degree of texturing.



X-ray diffraction  $\theta$ - $2\theta$  scans as a function of chi tilt for the screen printed thick film ink components.



Electron back scatter diffraction indicates greater than 90% alignment along the (001) (Imbedded image – pole figure).