Piezoelectric Ceramic Films and Micro-structures for MEMS Applications

Jing-Feng Li
State Key Laboratory of New Ceramics and Fine Processing, Department of Materials Science and Engineering, Tsinghua University, Beijing, 100084 P. R. China
E-mail:jingfeng@mail.tsinghua.edu.cn

Key Words: piezoelectric ceramics, film, crystal orientation, piezoelectric property, microfabrication

Microelectromechanical system (MEMS) is an attractive multidisciplinary field with significant progress occurring in research and application. Piezoelectric ceramic films and ordered or patterned microstructures are two key components for the MEMS applications. In this presentation, we will introduce our recent work related to processing of textured films and high-aspect-ratio microrod arrays of piezoelectric ceramics.

Piezoceramic films on a silicon substrate have attracted great attention in view of their potential applications in MEMS devices such as micro sensors and actuators. Usually, piezoceramic films have much lower piezoelectric properties compared to bulk materials, so it is necessary to endow the films with a preferential orientation to enhance its piezoelectric properties. Our recent work focused on the crystal-orientation control of sol-gel-derived PZT films using a seeding layer between the most underlying surface of PZT ($Pb(Zr,Ti)O_3$) film and platinum electrode surface. We fabricated single perovskite PZT thin films with absolute (100) texture by using lead oxide as the seeding crystal, and highly [111]-oriented PZT films by using titanium dioxide seeds. The dielectric and ferroelectric properties of PZT films with different preferential orientations were evaluated systemically as a function of composition, and higher piezoelectric coefficient d_{33} was obtained for the (100)-textured films. Most recently, we successfully prepared epitaxial PZT films on $SrTiO_3$ wafers also using the sol-gel method. The epitaxial PZT films showed considerably high remnant polarization and low coercive field, as compared with conventional PZT films on Si wafers. In particular, high d_{33} value up to 200 pC/N was obtained in the [001]-oriented epitaxial PZT films.

High-aspect-ratio array structures can be used to fabricate 1-3 composites with designed functionality, and such a composite of piezoceramic microrod arrays embedded within a polymer matrix is well suited for high-frequency medical imaging applications. This talk will also briefly introduce our recent research related to microfabication processing and characterization of ultrafine 1-3 piezoceramic/polymer composites.

Biographical Sketch

Name : Jing-Feng Li

Born : June 20, 1963

Nationality : Chinese

Affiliation : *State Key Laboratory of New Ceramics and Fine Processing, Department of Materials Science and Engineering, Tsinghua University, Beijing, 100084 P. R. China*

Tel: 86(10) 62784845, Fax: 86(10)62771160

E-mail: jingfeng@mail.tsinghua.edu.cn

Web: http://www.mse.tsinghua.edu.cn/faculty/lijf/lab/en/enindex.html

Title : Professor, Associate Department Chair

Prof. Jing-Feng Li is a full professor and associate chair of Department of Materials Science and Engineering, Tsinghua University, China. He has received master and doctor degrees both from Tohoku University (Japan) in 1988 and 1991, and a Bachelor of Engineering from Huazhong University of Science and Technology, China, in 1984. Prof. Li worked in Tohoku University as an assistant professor from 1992 to 1997, and an associate professor from 1997 to 2002. He has received Young Researcher Award from the Japan Institute of Metals in 1995, and Harada award from Harada foundation in 1998. Prof. Li joined Tsinghua as a full professor in 2002. He has published >180 papers and 11 patents and co-authored three books, and has been awarded Outstanding Young Scientist from NSF of China in 2003. Prof. Li is an Associate Editor (P. R. China) for Journal of Materials Processing Technology and council members of Chinese Ceramic Society and Chinese Society of Micro-nano Technology. His current research interests include piezoelectric ceramics and films, MEMS device structure and microfabrication technology, thermoelectric materials and devices; mechanical properties of advanced ceramics.