5th International Conference and Expo on

# Ceramics and Composite Materials

June 03-04, 2019 | London, UK

## *Kenji Uchino*[1, 2]

[1]*International Center for Actuators & Transducers, USA*

[2]*The Pennsylvania State University, USA*

## Glory of piezoelectric perovskites

The 'perovskite' ceramics are current primary piezoelectric materials widely commercialized and applied to various devices such as sensors and actuators. This paper reviews the piezoelectric perovskite history and forecasts the future development trend. $BaTiO_3$ (BT) ceramics were discovered during World War II independently in three countries, US, Japan and Russia. Following the methodology taken for the BT discovery, the perovskite isomorphic oxides such as $PbTiO_3$, $PbZrO_3$ and their solid solutions were intensively studied. In particular, the discovery of super piezoelectricity in the $Pb(Zr,Ti)O_3$ (PZT) system is noteworthy. In parallel to the PZT-based ternary solid solutions development, complex perovskite structure materials were synthesized and investigated in the 1950s. Among them, huge dielectric permittivity was reported in $Pb(Mg_{1/3}Nb_{2/3})O_3$ (PMN), which became major ceramic compositions for high-K capacitors in the 1980s. It is noteworthy to introduce two epoch-making discoveries in the late 1970s, relating with electromechanical couplings in the relaxor ferroelectrics: electrostrictive actuator materials, and high k piezoelectric single crystals. The author's group focused on the single crystal $Pb(Zn_{1/3}Nb_{2/3})O_3$-$PbTiO_3$ solid solution system, which has a phase diagram similar to the PZT system.

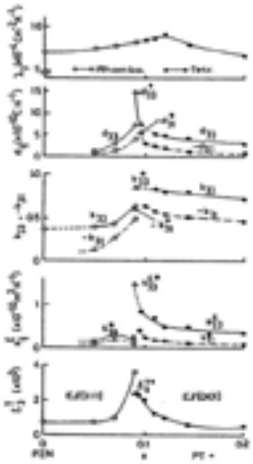

**Figure:** Changes in electromechanical coupling factors with PT faction x in (1–x) Pb $(Zn_{1/3}Nb_{2/3})$ $O_{3-x}PbTiO_3$.

## Recent Publications

1. S Nomura and K Uchino (1982) Crystal structure and physical properties of complex perovskite oxides. Solid State Phys. 18(2):71-86.
2. K Uchino (2010) The development of piezoelectric materials and the new perspective. Chapter 1, Advanced Piezoelectric Materials, Woodhead Publishing series, Cambridge, UK 1-85.
3. Li X, Schwacha M G, Chaudry I H and Choudhry M A (2008) Acute alcohol intoxication potentiates neutrophil-mediated intestinal tissue damage after burn injury. Shock 29(3):377-383.
4. J Kuwata, K Uchino and S Nomura (1982) Dielectric and piezoelectric properties of 0.91Pb ($Zn_{1/3}Nb_{2/3}$) $O_{3-0.09}PbTiO_3$ single crystals. 21:1298-1302.
5. K Uchino (2014) Piezoelectric actuator renaissance. J. Energy Harvesting and Systems 1(1-2):45-56.

## Biography

Kenji Uchino is the pioneer in "piezoelectric actuators", is the Founding Director of International Center for Actuators and Transducers, Professor of EE and MatSE, and Distinguished Faculty of Schreyer Honors College at The Penn State University. He was the Founder and Senior Vice President of Micromechatronics Inc., State College, PA from 2004 till 2010, and Associate Director at Office of Naval Research-Global from 2010 till 2014. After his PhD degree from Tokyo Institute of Technology, Japan, he became Research Associate in 1976 at this university. Then, he joined Sophia University, Japan as an Associate Professor in 1985. He was recruited from The Penn State in 1991. He has authored 570 papers, 75 books and 31 patents in the ceramic actuator area. 48 papers/books have been cited more than 100 times, leading to his average h-index 70. He is the Fellow of American Ceramic Society and IEEE. He is currently the IEEE UFFC Distinguished Lecturer.

kenjiuchino@psu.edu

**Notes:**