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Antiferroelectric shape memory ceramics

Antiferroelectrics (AFE) can exhibit a 'shape memory function controllable by electric field', with huge isotropic volumetric expansion associated with the AFE to Ferroelectric (FE) phase transformation. In the $\text{Pb}_{0.99}\text{Nb}_{0.02}[(\text{Zr}_{0.6}\text{Sn}_{0.4})_{1-y}\text{Ti}]_y\text{O}_3$ (PNZST) system, the shape memory function is observed in the intermediate range between high temperature AFE and low temperature FE, or low Ti-concentration AFE and high Ti-concentration FE. In the AFE multilayer actuators (MLAs), the crack is initiated in the center of a pair of internal electrodes under cyclic electric field, rather than the edge area of the internal electrodes in normal piezoelectric MLAs. The two-sublattice polarization coupling model is proposed to explain: (1) isotropic volume expansion during the AFE-FE transformation, and (2) piezoelectric anisotropy. We introduce latching relays and mechanical clampers as possible unique applications of shape memory ceramics.

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 $0.91\text{Pb}(\text{Zn}_{1/3}\text{Nb}_{2/3})\text{O}_{3-0.09}\text{PbTiO}_3$ 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.

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