This paper reports the efforts made in our laboratory to develop electrochemical sensors that might detect NO_x at high temperatures for OBD application. The non-Nernstian behaviour of zirconia-based electrochemical NO_x sensors with various oxides as sensing electrodes was studied in the temperature range 500–700 °C. Both pellets and tape-casted layers (150 μm of thickness) of yttria-stabilized zirconia (YSZ) were used for fabrication of the sensors. One of the electrodes was made of a thick-film of oxide. Various oxides were tested as sensing electrodes, either p- or n-type semiconductors, including WO_3, In_2O_3, $LaFeO_3$, and La_2CuO_4. The role of ionic conductivity of the oxide electrodes was investigated using Sr-doped perovskite-type oxides, such as $La_xSr_{1-x}FeO_3$, a mixed electronic-ionic conductor. All the oxides were chosen for their catalytic activities in NO_x reduction or their good performance as conductometric NO_x sensors. The sensors were tested in potentiometric devices. Amperometric and electrochemical impedance spectroscopy measurements were performed to understand the sensing mechanism. Long-term measurements were carried out to investigate the stability of the sensors. The performance of these devices was promising: fast (about 15 s for WO_3-based sensors) and stable responses to different NO_2 concentrations (20–1000 ppm in synthetic air) were observed at high temperatures. Good reproducibility was observed, even though a CO cross-sensitivity was measured. The role of the metallic electrodes was also studied. Particular attention will be given to the sensing mechanism of the sensors, which in some cases cannot be ascribed to mixed potential [E.D. Bartolomeo, M.L. Grilli, E. Traversa, Sensing mechanism of potentiometric gas sensors based on stabilized zirconia with oxide electrodes: is it always mixed potential?, Journal of the Electrochemical Society 151 (2004) H133–H139]. For practical application in OBD systems, field tests were performed testing the sensors on an engine, and the results will be presented.

doi: 10.1016/j.ceramint.2004.03.018

Relaxor-based piezoelectric single crystals: recent development and present understanding

Zuo-Guang Ye
Department of Chemistry, Simon Fraser University, Burnaby, BC, Canada V5A 1S6
Tel.: +1-604-291-3351; fax: +1-604-291-3765.
E-mail address: zye@sfu.ca (Z.-G. Ye).

Single crystals of the solid solutions between relaxor $Pb(Mg_{1/3}Nb_{2/3})O_3$ [PMN] or $Pb(Zn_{1/3}Nb_{2/3})O_3$ [PZN], and ferroelectric $PbTiO_3$ [PT], exhibit outstanding piezoelectric properties that have pointed to the next generation of electromechanical transducer applications. On the other hand, the mechanism of relaxor ferroelectricity remains a fascinating puzzle. It is believed that the excellent properties of the relaxor-based single crystals are closely related to the morphotropic phase boundary (MPB) effects, the symmetry of the MPB phases and the formation of meso- and macrodomain structures. Studies of the MPB-related properties, especially the symmetry of the MPB phases (with the presence of a monoclinic phase), the polarization rotation paths, and the domain structures, have helped us understand the fundamental of the enhanced piezoelectricity in these systems.

This talk will give an overview of recent developments in relaxor-based piezoelectric single crystals and the present understanding of the molecular mechanism of the outstanding properties in terms of polar nanostructure, crystal symmetry, morphotropic phase boundary, crystal growth, dielectric relaxation, domain structures and anisotropic properties.

Further reading

[1] Z.-G. Ye, Relaxor ferroelectric complex perovskites: structures, properties and phase transitions, Key Eng. Mater. 155–156 (1998) 81.
[2] S.-E. E. Park, W. Hackenberger, High performance single crystal piezoelectrics: applications and issues, Curr. Opinion Solid State Mater. Sci. 6 (1) (2002) 11.
[3] L. Bellaiche, Piezoelectricity of ferroelectric perovskites from first principles, Curr. Opinion Solid State Mater. Sci. 6(1) (2002) 19.
[4] B. Noheda, structure and high-piezoelectricity in lead oxide soild solutions, Curr. Opinion Solid State Mater. Sci. 6(1) (2002) 27.
[5] Z.-G. Ye, Crystal chemistry and domain structure of relaxor piezocrystals, Curr. Opinion Soild State Mater. Sci. 6(1) (2002) 35.
[6] A. A. Bokov, Z.-G. Ye, Morphotropic phase boundary and related properties in relaxor-based piezoelectric perovskite soild solutions, in: R. Guo, et al. (Eds.), Morphotropic Phase Boundary Perovskites, High Strain Piezoelectrics, and Dielectric Ceramics, Ceramics Transaction, vol. 136, The American Ceramics Society, 2003, pp. 37–53.

doi: 10.1016/j.ceramint.2004.03.019

Electrical properties of highly ionic conductive oxide thin films: applications in solid state fuel devices

C.L. Chen
University of Houston, Houston, TX, USA
Tel.: +1-713-743-8317; fax: +1-713-743-8201.
E-mail address: clchen@uh.edu (C.L. Chen).

The highly ionic conductive oxide thin films, such as $(La,Sr)CoO_3$, $Gd{:}CeO_2$, and others, have been synthesized by pulsed laser ablation. Microstructural characterizations with X-ray diffraction and electron microscopy indicated