superior microwave behaviors of the bismuth pyrochlore structure is to be discussed.

doi: 10.1016/j.ceramint.2004.03.006

Piezoelectric transducer arrays

R.E. Newnham
251-A Materials Research Laboratory, The Pennsylvania State University, University Park, PA 16802, USA
* Tel.: +1-814-865-1612; fax: +1-814-865-7593.
E-mail address: bobnewnham@psu.edu (R.E. Newnham).

Our research group has been involved in piezoelectric transducers for thirty years and has developed several well-known designs. We hold the original patents on the 1–3 piezocomposites and the commercially successful moonie transducers. This talk describes more recent work on flat transducer arrays constructed from miniature flex-tensional transducers (cymbals) and small piezoelectric hollow spheres (BBs) embedded in polyurethane matrices. Several modifications were developed with the aid of computer modeling including the double-dipper (high pressure capability), the double-driver (cardioid beam patterns), and smart caps made from shape memory alloys (adjustable resonant frequency). Applications for the cymbal-based designs include deployable arrays for undersea surveillance and transdermal insulin delivery for the treatment of diabetes. The higher-frequency BBs are used as miniature hydrophones and in the treatment of localized cancer.

doi: 10.1016/j.ceramint.2004.03.007

Progress prospects and problems in advanced materials for dielectric piezoelectric and electro-optic applications

L.E. Cross*
Materials Research Institute, Pennsylvania State University, University Park, PA 16802, USA
* Tel.: +1-814-865-1181; fax: +1-814-863-7846.
E-mail address: lec3@psu.edu (L.E. Cross).

Dielectric applications still provide major driving force for research and development on oxide electro-ceramics to serve this substantial market. Current excellent progress in dielectric/electrode systems for co-fired base metal electrode multilayer ceramic capacitors will be discussed. Research on switchable dielectrics for high power systems and frequency agile field tunable dielectric for microwave filter needs will be briefly outlined. In non-volatile random access memories (FeRAMS) ferroelectric thin films on silicon continue to make good progress. Low count, low power, low-cost memories for smart cards using bismuth oxide Aurivillius phase ferroelectrics are now in production. Fatigue and imprint problems for lead zirconate titanate (PZT) based films for high density memories appear to have been solved, whilst very new ultra high ($100\,uc/cm^2$) polarization switching has recently been demonstrated in $BiFeO_3$ epitaxial films. The clamant but highly intractable problems of ultra-thin higher permittivity gate dielectrics for sub micron field effect transistors (FETs) will be briefly outlined.

In piezoelectric and electrostrictive materials for elastic strain sensing and actuation, material systems with wide new ranges of elastic stiffness are being introduced. In the ultra-soft category exceptional sensitivity polymer foam electret sensors from VTT in Finland and soft electrostrictior actuators from SRI in the USA will be considered. Of intermediate stiffness are the irradiated PVDF:TrFE copolymers and the newer terpolymers from Penn State which provide excellent energy density. In stiff high strain/high coupling materials, oriented single crystals in the lead magnesium niobate: lead titanate (PMN:PT) and lead zinc niobate: lead titanate (PZN:PT) systems provide unique capability for sonar and ultra sonic tomography systems. The newer bismuth ferrate based systems which promise wider ferroelectric range at the polable morphotropic phase boundary compositions will be briefly introduced.

For the very widely used lithium niobate, lithium tantalite families of electro-optic crystals recent work has highlighted the profound effect on ferroelectric switching of oxide stoichiometry, where electrical coercivity is reduced by orders of magnitude in properly stoichiometric crystals. All the most widely used crystals are of the more easily grown congruently melting non-stoichiometric composition. The observed massive changes in switching makes us nervous in that much of our understanding of domain switching has come from research on similarly non-stoichiometric mixed oxide systems.

New researches on multi-ferroic systems are at last showing promise of interesting high coupling ferroelectric: ferromagnets in both single phase and composite systems, opening the possibility for completely new areas of application.

doi: 10.1016/j.ceramint.2004.03.008

The new frontier of vacuum microelectronics—diamond and carbon derived cold cathodes

W.P. Kang*, J.L. Davidson, A. Wisitsora-at, Y.M. Wong, R. Takalkar
Department of Electrical Engineering and Computer Science, Vanderbilt University, Nashville, TN 37235, USA
* Corresponding author. Tel.: +1-615-322-0952;
fax: +1-615-343-6614.
E-mail address: wkang@vanderbilt.edu (W.P. Kang).

Chemical vapor deposited diamond or related carbon are excellent cathode materials for vacuum microelectronics because of their low electron affinity and excellent mechanical and chemical properties. However, the “direct” usage of diamond or other forms of carbon emitters leads to non-uniform emitter microstructures, uncontrolled randomly scattered emission sites, and inconsistent emission behaviors. Consequently, practical engineering design and