Electroceramics XIII

June, 24th-27th 2012

University of Twente, Enschede, The Netherlands

Carlo model built for a ferroelectric/nonferroelectric layered system, local incomplete poling and switching with abnormal clockwise loops were obtained in specific positions close to the interfaces.

Although a typical ferroelectric behavior was not clearly demonstrated, the observed properties might result from a combination of $BaTiO_3$-like ferroelectric order within perovskite layers with non-ferroelectric behavior of the spinel layers and charge defect-associated effects.

P.83	**Effect of combined thermo-mechanical loading on the domain texture and the fracture resistance of lead zirconate titanate ceramics** Marco Deluca[1,2], Humberto M. Foronda[1,3], Raul Bermejo[1], Clemens Krautgasser[1,2], Jacob L. Jones[3], Peter Supancic[1,2] [1]Institut für Struktur- und Funktionskeramik, Montanuniversität Leoben, Austria; [2]Materials Center Leoben Forschung GmbH, Leoben, Austria; [3]Materials Science and Engineering, University of Florida, Gainesville, FL, USA

Lead zirconate titanate (PZT) is nowadays the most important piezoceramic for commercial high-performance actuators. In order to improve the design of existing devices it is mandatory to study the effect of combined thermo-mechanical loadings on their structural integrity. This is influenced by the in-service propagation of cracks introduced during poling. Crack propagation in PZT is intimately related with the microscopic domain structure. Ferroelastic switching of domains in front of an advancing crack consumes elastic energy, thus producing an extrinsic toughening effect. The investigation of the crack growth resistance (CGR) and the domain texture in dependence of combined thermo-mechanical loads is thus extremely important to provide guidelines to improve the toughness of piezo-actuators.

In the present work, poled and unpoled bulk PZT specimens were subjected to several compressive loads at 25°C, 150°C, 300°C and above the Curie temperature in an universal testing machine equipped with a temperature chamber. This procedure changes the pre-existing domain texture in the material, thus influencing the CGR (measured here with the indentation fracture method) in several directions. Polarised Raman spectroscopy was used to measure semi-quantitatively the texture of ferroelectric domains in dependence of the combined loading, upon assumption of suitable texture models for the domain orientation distribution. This allowed us to correlate the differences in the CGR with the sample history and the resulting domain configuration, thus highlighting domain texture's crucial role for crack propagation in PZT.

P.84	**Domain engineering in ferroelectric thins films by nanopatterened bottom electrodes** Brian F. Smith, Bouwe Kuiper, Andre ten Elshof, Guus Rijnders, Gertjan Koster University of Twente, Mesa+ Institute for Nanotechnology, Enschede, Netherlands

Ferroelectric thin films are used in a wide range of device applications from MEMS sensors and actuators to non-volatile random access memories. The wide range of applications is due to several attractive properties of ferroelectrics such as high dielectric permittivities and reversible spontaneous polarization. The domain structure of a ferroelectric film has a large influence on the properties of the film and therefore controlling the domain structure is essential to optimize their properties and performance. Furthermore, different applications of ferroelectric thin films need different domain structures for optimum performance. Domain engineering has been achieved by control of the misfit strain through epitaxial growth on substrates with different lattice

constants. However, this method only influences the relative domain populations and does not allow specific control over the domain structure.
Here we report domain engineering in ferroelectric thin films by using a nanopatterened bottom electrode. Pulsed laser deposition epitaxial grown ferroelectric thin films of PbTiO3 and BiFeO3 have been grown on self assembled SrRuO3 nanopatterns 5nm thick and with lateral dimensions of 100-200nm. The patterned SrRuO3 changes the mechanical boundary conditions of the ferroelectric film and as a result new domain structures are obtained with features corresponding to the SrRuO3 patterns. This technique allows nanometer control of the domain structure in ferroelectric films that has not previously been achieved.

P.85	**Piezoelectric and mechanical properties of structured PZT-epoxy composites** Nijesh K.James[1], Daan A. van den Ende[1,2], Ugo Lafont[1], Wilhelm A. Groen[1,2], Sybrand van der Zwaag[1] [1]Novel Aerospace Materials Group, TU Delft, Netherlands, 2629HS; [2]Holst Centre, TNO, Eindhoven, Netherlands, 5606KN

The most commonly used piezoelectric materials for transducer and sensor applications are monolithic Lead Zirconate Titanate (PZT) ceramics. However their brittle nature, high stiffness as well as limited shapeablility makes them unsuitable for applications such as vibration or impact sensors. The fabrication of a composite material combining the advantage of the high piezoelectric sensitivity and dielectric constant of PZT together with the low density and high flexibility of polymers matrix will be of great interest for such applications. Conventional processing techniques for fabricating 1-3 PZT fibre-polymer composites are rather complex and expensive if a high degree of fibre alignment is required to obtain good sensing properties. In this study a dielectrophoresis technique was used to fabricate structured quasi 1-3 PZT-epoxy based composites using granular PZT powder. With this process, manufacturing simplicity remains comparable to 0-3 composites and production costs can be kept low. Piezoelectric and mechanical properties of the composites as a function of PZT volume fraction were investigated and compared with the corresponding unstructured 0-3 composites. Moreover, the effect of poling voltage on piezoelectric properties of the composite has been studied for different volume fractions of PZT. The experimentally observed piezoelectric and dielectric properties have been compared with recent theoretical models from which the interparticle distance can be deduced and such results are compared with experimentally obtained data from SEM micrographs.

P.86	**Dielectric properties and conductivity mechanisms of $Mg_xNi_{1-x}Fe_2O_4$ spinel ceramics** Zina Violeta Mocanu[1], Mirela Airimioaei[2], Alexandra Raluca Iordan[2], Mircea Nicolae Palamaru[2], Lavinia Curecheriu[1], Liliana Mitoseriu[1], [1]Physics, Alexandru Ioan Cuza University, Iasi, Romania, 700506; [2]Chemistry, Alexandru Ioan Cuza University, Iasi, Romania, 700506

Large-scale applications of ferrites have promoted the development of various chemical methods for preparation and an increased interest in understanding their functional characteristics. Among different types of ferrites, $MgFe_2O_4$ enjoys a special attention because of its vast applications in high-density recording media, heterogeneous catalysis, adsorption, sensors and magnetic technologies, while $NiFe_2O_4$ are one of the most important ferrites with reversed spinel structure. From this point of view, it is highly