DF 13: Electrical and mechanical properties

Time: Thursday 10:15–11:20 Location: MÜL Elch

DF 13.1 Thu 10:15 MÜL Elch

High-pressure crystal structure and Raman spectra of $Bi_{12}TiO_{20}$ sillenite — •Leonore Wiehl, Alexandra Friedrich, Eiken Haussuehl, Wolfgang Morgenroth, and Bjoern Winkler — Institut für Geowissenschaften, Goethe-Universität Frankfurt/Main, Germany

Sillenites, $Bi_{12}MO_{20}$ (M = Si, Ge, Ti), show outstanding electric and optical properties used in many applications, especially the photorefractive effect and a high photoconductivity, which are assumed to be correlated with the stereochemical activity of the $6s^2$ lone electron pair of Bi^{3+}. At ambient conditions the Bi^{3+} lone pair is oriented towards an unoccupied corner in the distorted $BiO_5\square$ octahedron. Thus the stereochemical activity is expected to decrease under high external pressure. The crystal structure of $Bi_{12}TiO_{20}$ (BTO) was determined from a single crystal at 9.2(2) GPa in a diamond anvil cell by X-ray diffraction with synchrotron radiation at HASYLAB (D3), Hamburg. Powder diffraction experiments were performed with synchrotron radiation at ESRF (ID09A), Grenoble up to a pressure of 37 GPa. On pressure release of the same sample, Raman spectra were measured in the pressure range from 37 GPa to ambient conditions. The bulk modulus is $B_0 = 50(1)$ GPa. The Bi^{3+} lone pair remains stereochemically active up to the highest pressure reached in this study.

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DF 13.2 Thu 10:35 MÜL Elch

PVD grown high-k $SrTiO_3$ for capacitor applications: reliability and leakage current behavior — •Steve Kupke[1], Uwe Schröder[1], Steve Knebel[1], Sebastian Schmelzer[2], Ulrich Böttger[2], and Thomas Mikolajick[1] — [1]NaMLab gGmbH, Nöthnitzer Straße 64, D-01187 Dresden, Germany — [2]Institut für Werkstoffe der Elektrotechnik 2, RWTH Aachen University, Sommerfeldstraße 24, D-52074 Aachen, Germany

Low rate rf-sputtering was used to grow a 12 nm $SrRuO_3/SrTiO_3/SrRuO_3$ thin film capacitor with high dielectric constant and low leakage current behavior [1]. Leakage current analysis and time dependent dielectric breakdown (TDDB) measurements as a function of temperature were performed. Poole-Frenkel emission and trap assisted tunneling were found to explain the leakage current behavior at different electric field ranges. Shallow trap levels between 0.75 - 0.85 eV below the conduction band were found whereas at higher temperatures conduction is governed by deeper traps at 1.2 eV. Constant voltage stress (CVS) measurements indicate that electron trapping is predominant and stress induced leakage current occurs before hard breakdown. Based on the Weibull model a projected lifetime of several years was obtained at product conditions. The high lifetime in combination with a high effective permittivity of approximately 200 making it a promising candidate for future DRAM applications.

[1] S. Schmelzer et al., Appl. Phys. Lett. 97, 132907 (2010)

DF 13.3 Thu 10:55 MÜL Elch

Spectroscopic investigation of electro-coloration in Fe:$SrTiO_3$ — •Christian Lenser[1], Regina Dittmann[1], Kristof Szot[1], Aleksandr Kalinko[2], Alexei Kuzmin[2], Juris Purans[2], and Rainer Waser[1,3] — [1]Peter Grünberg Institut (PGI-7), Forschungszentrum Jülich, Jülich, Germany — [2]Institute of Solid State Physics, University of Latvia, Riga, Latvia — [3]Institut für Werkstoffe der Elektrotechnik, RWTH Aachen, Aachen, Germany

Electro-coloration of single crystals can be used as a model for the electroforming process of valence-change non-volative memory materials such as $SrTiO_3$ and TiO_2, which is necessary to access the switching properties of the material. Fe-doped $SrTiO_3$ single crystals are electro-colored by applying a DC-voltage between two evaporated Au-electrodes and stepwise increasing the current until metallic conductivity is reached.

The regions near the anode and cathode of the single crystal are investigated by X-ray absorption fine structure (XAFS), electron paramagnetic resonance (EPR) and Raman spectroscopy. EPR data show the presence of Fe^{3+}-oxygen vacancy complexes in the cathodic region, as well as their absence in the anodic region. The concentration gradient of oxygen vacancies created by the electro-coloration process is correlated to the local environment of Fe-centers as investigated by XAFS, and the effect of complexation and oxidation state on the pre-edge intensity and Fe-O bond length is discussed.

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