DF 18: Applications of dielectric solids

Time: Thursday 16:00–17:20 Location: MÜL Elch

DF 18.1 Thu 16:00 MÜL Elch

Nanometer thin tantalum oxide capacitors: Characterization of temperature stability and built in electric fields. — •Katrin Bruder[1], Kevin Stella[2], and Detlef Diesing[2] — [1]Heraeus Clevios GmbH, Chempark Leverkusen — [2]Fakultät für Chemie, Universität Duisburg-Essen, D-45117 Essen, Germany

Tantalum oxide based capacitors are widely used in electronic applications. A big amount of works exists for thicker oxide films $d > 10\,\mathrm{nm}$. However, for the production of high capacitance values per area thinner oxide films $d < 10\,\mathrm{nm}$ are of significant interest since the capacitance scales with d^{-1}. We present current-voltage experiments with 2 to 5 nm thick tantalum oxide capacitors. The temperature of the devices was varied from 40 K to 500 K. To avoid degradation of the devices the experiments were carried out under ultra high vacuum conditions. Tantalum oxide capacitors were found to be stable in the mentioned temperature range. By monitoring the temperature and voltage dependence of the device current one can determine the built in electric field $E_{\mathrm{built-in}} = 0.15\mathrm{V/nm}$. Deviations from the bulk dielectric behaviour were found for the dielectric permittivity ϵ_{rel}. Thin films only show values from 8 to 12 in contrast the bulk value of 28. This finding is attributed to asymmetric dipole layers at the oxide interfaces and smeared out band edges inside the vitreous oxide film. The asymmetry of the dipole layers may also evoke the built-in electric field.

DF 18.2 Thu 16:20 MÜL Elch

Colossal Dielectric Constants in Transition-Metal Oxides — •Stephan Krohns[1,2], Peter Lunkenheimer[1], and Alois Loidl[1,2] — [1]Experimental Physics V, Center for Electronic Correlations and Magnetism, University of Augsburg, Germany — [2]Institute for Materials Resource Management, University of Augsburg, Germany

Systems showing so-called colossal effects have an enormous potential as building blocks for future correlated electronics, including capacitors for energy storage and integrated circuits. For example, in the past decade the generation and investigation of very-high ("colossal") dielectric constants (CDC) has been an active field of basic and applied research. The measurement of the dielectric response to ac electric fields is one of the most powerful techniques to provide detailed insight into the underlying physics responsible for CDCs, which may comprise very different phenomena, e.g., charge order, molecular or polaronic relaxations, hopping charge transport, ferroelectricity or density-wave formation. Most of the materials exhibiting these effects, among them numerous transition-metal oxides [1], have complex ground states emerging from strong electronic correlations. For example, charge-ordered $La_{2-x}Sr_xNiO_4$ exhibits CDCs up to gigahertz frequencies at room temperature [2]. Here, we thoroughly discuss the mechanisms that can lead to colossal values of the dielectric constant in transition-metal oxides, especially emphasising effects generated by external and internal interfaces, including electronic phase separation.

[1] P. Lunkenheimer *et al.*, Eur. Phys. J. Special Topics **180**, 61 (2010). [2] S. Krohns *et al.*, Appl. Phys. Lett. **94**, 122903 (2009).

DF 18.3 Thu 16:40 MÜL Elch

CVD Diamond for sub-mm and THz applications — •Theo Scherer, Dirk Strauss, and Andreas Meier — Karlsruhe Institute of Technology KIT ; IMF-1 Hermann-von-Helmholtz-Platz 1 D-76344 Eggenstein-Leopoldshafen, Germany

Diamond is an outstanding material with a extremely high thermal conductivity and a very low loss tangent of < 10-5 for GHz frequencies and shows therefore a very small microwave absorption. To understand the loss mechanisms at the surface and in the bulk material of diamond the determination of loss tangent in dependence of the frequency in the range of several GHz up to THz is essential. The main absorption mechanisms for ultra-low loss materials will be described and prospects will be given for advancing these materials in the THz region. A reduction of the losses at the surface can be realized by special chemical treatment and surface finishing of the CVD diamond disk material. Resonator measurements and experimental setups for the GHz- and the THz-range will be discussed.

DF 18.4 Thu 17:00 MÜL Elch

Glass-ceramics with paraelectric phases for mobile applications in the GHz-range — •Hubertus Braun[1,2], Martin Letz[1], and Gerhard Jakob[2] — [1]Schott AG, Hattenbergstraße 10 Mainz — [2]Johannes Gutenberg-Universität Mainz

In the last years, handheld devices such as global positioning systems (GPS), satellite phones and radios have required antennas that communicate directly with the satellite. The most attractive technology for this purpose is based on dielectrically loaded antennas (DLA) which utilise microwave ceramics. The advantage of the dielectric antenna technology lies mainly in the miniaturisation by $\frac{1}{\sqrt{\varepsilon_r}}$ and in the resistance to detuning ("Body Loading") by nearby objects, as for example human tissue. Selective parameters for the needed ceramics are high quality factor Qf $>$ 5000 GHz, near zero temperature coefficient of resonance frequency $|\tau_f| \leq 20$ ppm/K and permittivity $\varepsilon_r > 20$. A possible alternative to usual ceramic fabrication techniques is the use of glass-ceramic technology in which the antenna cores can be cast to net shape followed by crystallisation to achieve intrinsic pore free materials with the desired microwave properties. In the current work, promising low melting temperature dielectric glass-ceramics in the La-Ti-Si System are analysed concerning suitability for DLA applications and lower cost fabrication techniques.