HL 88: GHz Dielectrics - Materials for mobile communication II (DF with DY/HL/MM)

Organizer: Martin Letz (Schott AG Mainz)

Time: Thursday 15:00–17:00 Location: EB 407

Topical Talk HL 88.1 Thu 15:00 EB 407

Temperature stable low loss ceramics for resonators and filters — •Ian Reaney — Materials Science and Engineering, University of Sheffield, Sheffield, UK

Micro wave (MW) dielectric ceramics are required to be temperature stable and have a low dielectric loss to prevent heating of the sample when operated at or near resonance. They are used in many applications but specifically in this contribution the use of MW dielectric ceramics as resonators, filters and antennas is considered. The relevant technologies for these application are reviewed along with their selective materials parameters. The underpinning crystal chemistry that leads to optimisation of properties is also reviewed and some new materials and novel processing routes to improve device performance are discussed.

HL 88.2 Thu 15:30 EB 407

Titanate-based paraelectric glass-ceramics for applications in GHz electronics — •Hubertus Braun[1,2,3], Martin Letz[2], Martun Hovhannisyan[2], and Hans-Joachim Elmers[1] — [1]Johannes-Gutenberg Universität Mainz — [2]SCHOTT AG, Mainz — [3]Graduate School Materials Science in Mainz

In the current work, titanate-based glass-ceramics ($TiO_2 > 45$ mol %) in the La_2O_3-TiO_2-SiO_2-B_2O_3 system are developed ($\varepsilon_r \approx$ 20-30, Qf $\approx$ 10.000 GHz, $|\tau_f| <$ 10 ppm/K) which show promising properties as microwave materials and offer numerous advantages in comparison to conventional sintered ceramics. Glass-ceramics which are obtained via a true glassy phase are comparatively new in this field and will be presented as suitable alternative. Glass-ceramics are produced in a two step process: At first, a basic glass is casted in a conventional glass production process. Then the glass undergoes a temperature treatment with a defined temperature profile to initiate a controlled partial crystallization of desired paraelectric phases inside the glassy matrix. Obtaining materials via a homogeneous glassy phase enables intrinsically pore-free materials with comparatively superior surface properties. The effect of solid solution type doping on the dielectric properties and glass stability is investigated. The effect of solid solution type doping on the A(La) and B(Ti) site of the crystalline phases with ions of similar ionic radius is investigated concerning their influence on the dielectric properties and glass stability. Further the materials are analyzed concerning suitability for dielectric loaded antenna applications.

HL 88.3 Thu 15:50 EB 407

Microwave electric properties of thin-film $Ba_xSr_{1-x}TiO_3$ varactors with highly-conducting epitaxial $SrMoO_3$ oxide electrodes — •Arzhang Mani[1], Aldin Radetinac[1], Mohammad Nikfalazar[2], Sergiy Melnyk[2], Philipp Komissinskiy[1], Yuliang Zheng[2], Rolf Jakoby[2], and Lambert Alff[1] — [1]Institute of Materials Science, Technische Universität Darmstadt, 64287 Darmstadt, Deutschland — [2]Institut für Mikrowellentechnik und Photonik, Technische Universität Darmstadt, 64283 Darmstadt, Deutschland

We present high-frequency properties of MIM thin-film varactors with dielectric $Ba_xSr_{1-x}TiO_3$ (x = 0.4, 0.5, 0.6). Single crystalline $Ba_xSr_{1-x}TiO_3$ layers were grown epitaxially on highly-conducting oxide $SrMoO_3$ electrodes with room-temperature resistivity of 30 $\mu\Omega\cdot$cm. Au/Pt top electrodes were deposited by magnetron sputtering on top of the $Ba_xSr_{1-x}TiO_3$ / $SrMoO_3$ heterostructures and patterned with photolithography and lift-off. Influence of Ba content (x), thickness of $Ba_xSr_{1-x}TiO_3$ layer, and size of the top electrodes on performance of the varactors were investigated in the frequency range of 100 MHz to 10 GHz. Capacitance of 15 pF, quality factor of 15, and tunability of 40% at 0.3 MV/cm were obtained at 100 MHz. The obtained results suggest a high potential of the oxide perovskite electrode material $SrMoO_3$ [1] for fabrication of highly tunable varactors in microwave applications.

[1] A. Radetinac *et al.*, Appl. Phys. Lett. **105**, 114108 (2014).

HL 88.4 Thu 16:10 EB 407

Continuously tuneable, high performance phase shifters based on liquid crystal for applications in phased array antennas — •Matthias Jost, Christian Weickhmann, and Rolf Jakoby — Institute of Microwave Engineering and Photonics, Technische Universität Darmstadt, Merckstr. 25, 64283 Darmstadt, Germany

During the last decade, calamitic-nematic liquid crystals (LCs), well-known from the LC-display technology (LCD), have become increasingly popular in the field of microwave engineering. Due to their unique property of exhibiting local anisotropy, they offer the possibility of realising passive, continuously tuneable devices, such as phase shifters, tuneable filters, polarisers or matching networks. LC can be oriented continuously between the two extreme states (parallel or perpendicular to an applied RF field), either by applying a magneto-static or an electro-static field. Depending on the orientation of the LC, its permittivity and dielectric loss changes. This work presents the recent progress of our research in the topic of hollow waveguide based LC phase shifters for application in phased array antennas. This kind of phase shifter is suitable for high performance applications due to its high figure of merit (FoM), defined by the ratio of the maximum differential phase shift over the highest insertion loss in all tuning states. Full wave simulation results as well as measurement results of realised phase shifters will be shown and a perspective of a phased array antenna for satellite communication will be given.

Topical Talk HL 88.5 Thu 16:30 EB 407

Low loss flexible and stretchable dielectrics for microwave applications — •Mailadil Sebastian — Department of Electrical Engineering, University of Oulu, 90014 Oulu

Flexible, bendable and stretchable dielectrics which can cover even curved surfaces are important for applications in electronic control systems, consumer electronics, heart pacemakers, body worn antenna etc. The requirements for a material to be used as a flexible dielectric waveguide are mechanical flexibility, high relative permittivity, low dielectric loss, high thermal conductivity, low coefficient of thermal expansion (CTE) etc. It is very difficult to identify a single material which possesses all these properties simultaneously. There are a number of ceramic materials with high relative permittivity and low dielectric loss but are brittle in nature. Butyl and silicone rubbers have low loss with good mechanical flexibility and stretchability but they have low relative permittivity and high CTE. Therefore, the practical applications of a rubber or a ceramic alone is limited. By integrating the flexibility, stretchability and low processing temperature of a rubber with high relative permittivity and low loss of ceramics, a composite may be formed, which can deliver improved performances. In this talk the effect of addition of several ceramics such as SiO_2, Al_2O_3, TiO_2, $Ba(Mg_{1/3},Ta_{2/3})O_3$, $Ba(Zn_{1/3},Ta_{2/3})O_3$, $BaTiO_3$, $Ba_{0.7}Sr_{0.3}TiO_3$, $SrTiO_3$, AlN, $Sr_2Ce_2Ti_5O_{15}$ in butyl and silicone rubbers on the microwave dielectric properties, thermal conductivity, thermal expansion, moisture absorption, mechanical properties etc will be discussed.