Low-loss dielectric ceramics with filled-type tungsten bronze structure were investigated in the $BaO–Ln_2O_3–TiO_2–Ta_2O_5$ (Ln = La, Nd, and Sm) systems, and the typical compounds $Ba_3Ln_3Ti_5Ta_5O_{30}$, $Ba_4Ln_2Ti_4Ta_6O_{30}$, and $Ba_5LnTi_3Ta_7O_{30}$ were synthesized and characterized. The present ceramics indicated high dielectric constant ε (103–175) and low dielectric loss $\tan\delta$ (in the order of 10^{-5} to 10^{-3} at 1 MHz). Meanwhile, the temperature coefficient of dielectric constant τ_ε varied from −728 to −2500 ppm/°C with increasing Ba and Ta and decreasing Ln and Ti concentration. The present ceramics are promising candidates for high-ε and low-loss dielectric materials, and the suppression of τ_ε should be the primary issue in the future work. Among the present ceramics, the Sm-based system indicated the highest dielectric constant combined with the highest dielectric loss and the largest temperature coefficient of dielectric constant, while the La-based system showed the lowest dielectric loss and the smallest temperature coefficient of dielectric constant.

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Frequency agile materials for tunable microwave electronics

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There are interesting developments in the area of microwave dielectrics which require wide range of dielectric permittivity single crystals, ceramics or composites. The emphasis of the research is to improve materials and develop component and subsystems for frequency agile communications and remote sensing that utilizes the field variable properties of ferroelectrics, paraelectrics, ferrites or other novel materials. The goal of the current research is to develop miniature devices with significant agility at appreciable lower loss than the state of the art. Such approach will provide the ability to tune the bandwidth and frequency of RF filters and antennas and subsequently will result in improved performance of RF systems for communications to remote sensing.

This talk will overview the wide range of dielectrics available for such applications and will also provide the spectrum of potential materials choices which earlier were not considered suitable for designing microwave devices.

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Calcite microcrystals in the pineal gland of the human brain: second harmonic generators and possible piezoelectric transducers

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A new form of biomineralization in the pineal gland of the human brain has been studied. It consists of small crystals that are less than 20 μm in length and that are completely distinct from the often-observed mulberry-type hydroxyapatite concretions. Cubic, hexagonal and cylindrical morphologies have been identified using scanning electron microscopy. Energy dispersive spectroscopy, selected-area electron diffraction and near infrared Raman spectroscopy established that the crystals were calcite. Experiments at the European Synchrotron Radiation Facility (ESRF) to study the biomineralization showed the presence of sulfur originating from both sugars and proteins. Other studies at the ESRF furnished information on the complex texture crystallization of the calcite. With the exception of the otoconia structure of the inner ear, this is the only known non-pathological occurrence of calcite in the human body. The calcite microcrystals are believed to be responsible for the previously observed second harmonic generation (SHG) in pineal tissue sections. There is a strong possibility that the complex twinned structure of the crystals may lower their symmetry and permit the existence of a piezoelectric effect.

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Bismuth-based pyrochlore and related ceramics for microwave application

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Bismuth-based pyrochlore and related materials are a group of ceramics with very low sintering temperatures in the range of 850–1000 °C. The dielectric constant of the ceramics is in the range of 40–100 with very low temperature coefficient in the range of lower than ±30 ppm/°C. The dielectric loss at high frequencies is in the order of 10^{-4}. The Q factor of the ceramics in microwave GHz frequencies is in the order of 10^2–10^4. $Bi_2O_3–ZnO–Nb_2O_5$, $Bi_2O_3–ZnO–Ta_2O_5$, $Bi_2O_3–ZnO–Sb_2O_5$ systems are studied systematically. Effect of substitution and co-substitution of ZnO and Nb_2O_5 by equal-valence and alien-valence cations for the BZN materials and the effect of chemical deviation of the stoichiometric composition on the dielectric behaviors and structures are presented. Discussion on the structure, defects, and property relationship of the materials are given in this presentation. A new understanding of the