Magnetoceramics: DC to Light and their role in today’s consumer and Defense electronics

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In this presentation, I will review past, present, and future RF applications of magnetoceramics. Magnetoceramics, sometimes referred to as magnetodielectrics, play an important role in the sending, receiving, and manipulation of electromagnetic signals from 1 GHz to optical frequency bands [1]. Applications include control elements in transmit and receive modules as circulators, isolators, filters, phase shifters, and limiters. More recently, they have been considered for next generation low-profile antenna substructures and superstructures. At frequencies below 1 GHz, they are pivotal materials for power generation, conditioning and conversion.

Structurally, they are oxides in which the anion forms a high packing efficient lattice in which cations occupy octahedral, tetrahedral, and occasionally dodecahedral sites. Spinels and garnets are cubic structures and offer very low anisotropy fields and low dielectric and magnetic loss. Large cation substitutions, such as Ba and Sr, lead to crystal symmetry breaking and hexagonal unit cells having remarkable magnetocrystalline anisotropy fields exceeding 4 T. Together, they offer materials solutions from DC to optical bands.

This presentation will focus largely on low loss, highly efficient magnetoceramic materials that break time reversal symmetry allowing for nonreciprocity in flow of electromagnetic waves.


Biography: Vincent Harris has had a distinguished career as an engineer, scientist, inventor, and entrepreneur for more than 30 years. He presently holds positions as University Distinguished Professor and the William Lincoln Smith Chair of Electrical and Computer Engineering at Northeastern University. He is the Founder and Director of the Center for Microwave Magnetic Materials and Integrated Circuits (CM3IC). Prior to holding these positions, he was a member of the technical staff, Head of the Complex Materials Section, and Head of the Materials Physics Branch at the Naval Research Laboratory (Washington, DC). His research interests include materials design and the study of processing, structure and magnetism in a wide range of electronic materials and devices used principally in ultrahigh frequency applications. He has published more than 360 technical articles in peer-reviewed science and engineering journals in these fields of study, including book chapters, review articles, and invited technical feature articles on the topical areas of nanotechnology, magnetism, and RF materials and devices. These articles have been cited in the scientific literature more than 10,000 times (h=50). Among his international prizes and awards, Harris was the recipient of the Minerals, Metals and Materials (TMS) Society Distinguished Scientist Award (2016), the Chinese Academy of Sciences’ Lee Hsun Research Award for seminal contributions to materials science (2013), and was an IEEE Distinguished Lecturer of the Magnetics Society. He has been elevated to Fellow of the AAAS, IEEE, American Physical Society, Institute of Engineering and Technology (UK), and Institute of Physics (UK). In 2016, Harris was named a Fulbright Scholar. He routinely serves as an expert panelist for the NAS/NAE, Department of Defense, Department
of Energy, National Science Foundation, and the Office of the Secretary of Defense (among others) in areas of national and international science, technology, and commerce. Vincent Harris is a veteran of the U.S. Coast Guard.