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Nanomaterials and additive manufacturing for RF, MW and THz devices

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This talk will present our recent research in the area of synthesis, RF characterization, strategic design, and employment of functional nanomaterials for a wide variety of RF/MW/THz devices. Magneto-dielectric and high-k dielectric nanocomposites have been developed as a new class of materials well-suited for electromagnetic wave devices. In particular, magnetic/dielectric nanoparticles have been synthesized and evenly dispersed in a host polymer matrix to tailor its effective microwave properties, thus improving antenna performance (i.e., size, gain, bandwidth, efficiency). The RF properties, including permittivity, permeability, dielectric and magnetic loss tangents, were extracted over a wide frequency range (0.1-20 GHz), while monitoring the effects of the nanofillers reinforcement and externally applied magnetic field.The magneto-dielectric Fe_3O_4-PDMS composites have been incorporated into miniaturized multilayer patch antennas with center frequency of 4 GHz that exhibited 58% of bandwidth enhancement and 57% of size reduction. Meanwhile, the effects of the sintering and other processes were rigorously studied that has led to improved dielectric and loss properties. Specifically, PDMS nanocomposites with sintered $NdTiO_3$ fillers have exhibited a high permittivity (ε_r~12) and loss tangent ($\tan\delta_d$<0.01) at frequencies up to 17 GHz on par with the loss of the typical PCBs. This new class low-loss nanocomposite is an enabler for the next generation of RF/MW/THz devices. A 3D multi-material additive manufacturing process is going to be employed to produce miniaturized 3D conformal microwave components. The talk will be concluded with a brief discussion of other ongoing activities, which focus on development of transmission-line based microwave devices and millimeter wave dielectric waveguides, etc.

Biography

Jing Wang is an Associate Professor of Electrical Engineering at the University of South Florida. He got two MS degrees, one in Electrical Engineering (2000), the other in Mechanical Engineering (2002), and a PhD degree (2006) all from the University of Michigan. His research interests include RF/microwave/THz devices and microsystems, micro machined transducers, and functional nanomaterials. He has published more than 90 peer-reviewed journal and conference papers, while serving as reviewer for more than a dozen journals. His work has been funded by research grants from federal agencies (NSF, DTRA, US Army, US Air force) and contracts from more than a dozen companies. He is the chairperson for IEEE MTT/AP/ED Florida West Coast Section and he is also the faculty advisor for Florida IMAPS, AVS and IMS student chapters. He was elected as a member the prestigious IEEE MTT Technical Committee on RF MEMS topics. He currently acts as the general co-chair for the IEEE Wireless and Microwave Technology Conference (WAMICON 2015).

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