

Microwave and Millimeter Wave NDE – Focus on Aerospace Applications

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Microwave and millimeter-wave signals span frequency ranges of ~300 MHz-30 GHz and 30 GHz-300 GHz, corresponding to wavelength ranges of 1000-10 mm and 10-1 mm, respectively. Signals at these frequencies readily penetrate inside of dielectric materials and composites and interact with their inner structures. The intrinsic nature of the interaction of these signals with material media, the relatively small wavelengths and wide bandwidths associated with these signals provide for the inspection of a variety of materials for their properties and presence of flaws with high sensitivity. Furthermore, availability of robust and advanced electromagnetic models and modeling tools, and improved imaging techniques rendering real-time, high-resolution (3D) images of materials and structures are specific and attractive features that have brought tremendous visibility and viability for microwave and millimeter wave nondestructive evaluation (NDE) techniques and applications. In addition, the diversity of composite materials and structures, used in the space and aerospace industries, has brought upon significant growth in the utility of these methods. Currently, these methods are capable of addressing critical NDE issues related to: *i*) characterization of multi-phase material and mixture composition, *ii*) evaluation of surface-breaking crack particularly those under thick non-conductive coatings, *iii*) inspection of complex layered composite structures, *iv*) detection of corrosion and pitting under coatings, *v*) inspection of aircraft radome, and *vi*) inspection and imaging of thermal protective layers, to name a few. Finally, advances in innovative hardware designs, development of easy-to-use software packages, and availability of commercial off-the-shelf (COTS) components and systems, have resulted in inspection systems that are affordable, portable, field-deployable and easy-to-use. Consequently, microwave and millimeter wave NDE methods are no longer to be considered as “emerging technologies” since they have been undergoing significant maturation over the past 3+ decades. This presentation provides an overview of these techniques, along with illustration of several typical examples of inspection focused on aerospace inspection.



R. Zoughi is the Kirby Gray (Battelle) Chair in Engineering and a Professor Electrical and Computer Engineering (ECpE) at Iowa State University (ISU). He is also the Director of Center for Nondestructive Evaluation (CNDE) at ISU. He served as the Schlumberger Endowed Professor of Electrical and Computer Engineering at Missouri University of Science and Technology (Missouri S&T) from January 2001 to August 2019. Prior to joining Missouri S&T and since 1987 he was with the Electrical and Computer Engineering Department at Colorado State University (CSU). Dr. Zoughi held the position of Business Challenge Endowed Professor of Electrical and Computer Engineering from 1995 to 1997 while at CSU. He is the author of a textbook entitled “Microwave Nondestructive Testing and Evaluation Principles” KLUWER Academic Publishers, 2000, and the co-author of a

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