

INVITED LECTURE:

MODELING-BASED MICROWAVE IMAGING IN CLOSED CAVITIES

by Professor Vadim V. Yakovlev (Worcester Polytechnic Institute)

sponsored by the Computational Electromagnetics Research Laboratory
McMaster University

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McMaster University
1280 Main Street West, Hamilton, ON L8S 4K1

ABSTRACT

The processing of ceramic and composite powders with microwaves is an innovative technique in the fabrication of new materials with unique physical properties. There is a significant interest in the computational approaches to the macroscopic modeling of this technology. The development of suitable models, however, is held back by the absence of data on the dielectric and thermal properties of the materials undergoing high-temperature microwave processing.

In this talk, we review the results of several projects dedicated to the development of a new approach to microwave imaging for the non-destructive evaluation (NDE) of materials in closed cavities. The approach, which is based on artificial neural network (ANN) optimization and 3D finite-difference time-domain (FDTD) simulation, is capable of reconstructing the internal structure of the samples from the measured S -parameters. We present results on: (a) finding the position and the size of a spherical object in a dielectric body, (b) reconstruction of the 2D & 3D profiles of the complex permittivity, and (c) determining the volume fraction of solids in particulate materials. Finally, we discuss the conditions under which the developed ANN-FDTD approach may become an attractive NDE methodology of microwave imaging in closed cavities.



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Vadim V. Yakovlev received his Ph.D. degree in Radio Physics from the Institute of Radio Engineering and Electronics (IRE) of the Russian Academy of Sciences (RAS), Moscow, Russia in 1991. From 1984 to 1996, he held junior to senior research positions with the IRE RAS and in 1993 he worked as a Visiting Researcher at Electricité de France (Centre Les Renardières). In 1996, he joined the Department of Mathematical Sciences, Worcester Polytechnic Institute, Worcester, MA, and currently holds the position of Research Associate Professor. Dr. Yakovlev is the Head of the Industrial Microwave Modeling Group which he established in 1999 as a division of the WPI's Center for Industrial Mathematics and Statistics. His research interests include multiphysics modeling, microwave power engineering, broadband/multiband antennas, neural-network-based optimization, and microwave imaging. He is an author of more than 150 papers in referred journals and conference proceedings. Dr. Yakovlev is a Senior Member of the IEEE and a Member of the IEEE MTT-S IMS TPRC. He is a Member of the Board of Governors of the International Microwave Power Institute (IMPI), and a Member of Association for Microwave Power in Europe for Research and Education (AMPERE).