Electromagnetic Characterization of Materials Using a Dual Chambered High Temperature Waveguide

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Measurement of the electromagnetic properties of materials at high temperatures is important for industrial, scientific, medical, and aerospace applications (L. Chen, et al., Microwave Electronics: Measurement and Materials Characterization, John Wiley, 2004). Current high-temperature electromagnetic material characterization is a time consuming process that typically requires three days to collect data from one material specimen. For example, the standard high temperature process involving rectangular waveguides (C. Larsson and D. Sjöberg, ICECom, 2010, 1-4) requires measurements of the sample (1), the empty waveguide (2), and a metal short standard (3) completed in separate heated runs over three days to perform the Nicolson-Ross-Weir (NRW) inversion algorithm for computing permittivity and permeability.

The technique developed here will reduce the high temperature measurement process from three days down to just one day. The research will utilize a position independent approach for isotropic materials that averages forward and reverse travelling waves for effective transmission and reflection parameters. It is shown that this averaging effect eliminates the need for a metal short measurement, thus reducing high temperature measurement time by one day. In addition, a new dual chambered waveguide design will help reduce measurement time down to just one day. This is accomplished through simultaneous measurement of the inserted sample in one of the chambers and the empty waveguide of the second chamber.

A vector network analyzer (VNA) will be used to run X-band data collects at incrementally increasing temperatures up to approximately 1000ºC. Results will include measured S-parameters from the VNA that will be processed to compute permittivity and permeability of the materials under test versus temperature. These results will be compared with other known techniques in order to validate the new high temperature process.

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