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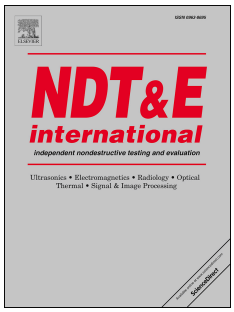

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Porosity Evaluation of In-Service Thermal Barrier Coated Turbine Blades Using a Microwave Nondestructive Technique

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Abstract— Porosity inspection of composite materials, ceramics and polymers is an important practical consideration in the nondestructive evaluation/testing (NDE/T) industry. The porosity of ceramics such as yttria stabilized zirconia (YSZ), the most widely used thermal barrier coating (TBC), for hot section metal components in a gas turbine is highly correlated with the thermal conductivity performance of the component. In-situ porosity inspection of TBCs after cyclic service is crucial to ensure the operational quality of TBCs and avoid any catastrophic system failure. The ability of microwave signals to propagate through a dielectric material and interact with the underlying surface and intrinsic properties, combined with the availability of high-resolution portable measurement equipment, make microwave imaging an attractive candidate for in-situ porosity inspection. In this paper, an extensive analysis of the simulation and measurement using a X-band open-ended rectangular waveguide (OERW) energy launch to evaluate the porosity of the TBCs of turbine blades is given. Existing mixing models are verified using simulation to determine the porosity and its relation to dielectric properties. The results show that the OERW microwave NDT/E technique can be used to characterize the porosity of TBCs, after cyclic services, using the phase of the reflection coefficient, S_{11}. The results are validated using waveguide dielectric property measurements and image analysis produced using a scanning electron microscope (SEM).

Keywords—Porosity, thermal barrier coating, turbine blade, open-ended waveguide, microwave NDT/E.