Simultaneous Density and Thermal Conductivity Depth Profile Reconstructions from Noised Thermal-wave Amplitude and Phase Data using a Combined Integral-equation and Imperialist Competitive Algorithm Method

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An efficient new thermal-wave inverse-problem approach based on an integral-equation boundary-value method coupled with an imperialist competitive algorithm (ICA) was developed. The methodology was successfully applied to *simultaneously* reconstruct density and thermal conductivity depth profiles in a sintered powder metallurgy sample from an industrial automotive manufacturer with inhomogeneous density depth profile and a surface layer of higher density than the bulk. The density depth profile was validated independently using the manufacturer's data and in-house porosity measurements. The present non-destructive inverse problem approach represents a generalized formalism to thermal-wave reconstruction optimization of dual depth profiles using frequency scan data measured from the interrogated surface. From a fundamental viewpoint, the method adds significant insights into the relationship between thermal conductivity and density distributions in inhomogeneous solids.