Thermal Wave Scattering by Buried Spheres

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In this work we present a model to calculate the surface temperature of an opaque material, containing a series of buried spheres, whose surface is illuminated by a periodically modulated light beam. The model includes the multiple scattering effects suffered by the plane thermal wave when interacting with the spheres and with the sample surfaces. A series solution to the heat diffusion equation and a matrix formulation to solve the scattering coefficients are used. The model is general in the sense that there are no restrictions on the spheres number, neither on their size and position inside the material nor on the thermal properties of spheres and sample. In a second step an inversion algorithm has been used to transform the solution from the frequency domain to the time domain. In this way the time evolution of the surface temperature of the material after a very short heating pulse is calculated. The models are validated by modulated and pulsed photothermal radiometry measurements on calibrated samples. A specific case of interest of the model is its application to the thermal characterization and non-destructive evaluation of dispersed composites, where spherical particles are embedded in a matrix to improve its mechanical, electrical and/or thermal properties. An inversion procedure to reconstruct the size and position of the spheres is under progress.