CLUSTERING, SURFACE PERTURBATION AND MATERIAL EFFECTS ON ABSORPTION AND SCATTERING BY RAYLEIGH PARTICLES

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For small particles shape dependent internal resonances of the reduced coupled electromagnetic-vibrational excitations lead to enhancements of the absorption and scattering cross sections $\sigma_A$ and $\sigma_S$ at certain critical frequencies, $f_c$. The $f_c$ lie within the absorption bands of the bulk material of which the particles are composed and correspond to negative values of the real part $\varepsilon'$ of the dielectric constant. The strength of $\sigma_A(f_c)$ and $\sigma_S(f_c)$ depends on the amount of internal damping and so increases with $\varepsilon''(f_c)$.

We have tracked (computationally) the variation of the $\varepsilon''$ values corresponding to the major resonances for a number of particle configurations of closely spaced or agglomerated particles as the geometry is changed. Very rapid changes in the $\varepsilon''$ values for some of the resonances occur as the particles become very close or have just merged. We have also tracked similar effects for surface grooves and losses on individual particles.

The tracking was done assuming the particles were composed of an unphysical low loss material in which $\varepsilon''$ was assumed frequency independent. In this way resonances were only lightly damped and so showed up clearly while, at the same time, particle shape and spacing effects were separated from the effects of the $\varepsilon''$ vs $f$ variation in real materials for each of which, within the absorption band, $\varepsilon''(f)$ varies rapidly and has a local maximum. Therefore plots for real materials of $\sigma_A$ vs $f$ can be considerably modified from those for the unphysical constant $\varepsilon''$ case. One expects that fine structure will be blurred and possibly that major peaks will be damped out in which case there would be little left of the resonance structure. By computing $\sigma_A$ vs $f$ in absorption bands for a representative metal, Cu and representative dielectric, SiC using published $\varepsilon''(f)$ data we find that some, but not all, of the important absorption peaks were damped.