Modeling the impact of silver particle size and morphology on the covering power and tone of photothermographic media

In order to study the effect of the silver particle morphologies in photothermographic images, we calculate exactly the scattering and absorption cross sections for a few distinct morphologies representing simplified limits of the morphologies actually seen in photothermographic images. In particular we consider isolated spheres, isolated prolate spheroids, and isolated 3 X 3 X 3 clusters of spheres. These results are then extended to compute approximately the covering power and tone in a slab containing a collection of such scattering and absorbing particles by using the solution to the telegrapher's equation that models the propagation of the light in a medium under the assumption that the light is scattered isotropically by the particles.

The anisotropy of the scattering is treated using a widely-used approximate correction that is shown to give reasonably good agreement with a Monte Carlo simulation of the light propagation for the case when the particles are spheres. Our results show that, for solid silver spheres, there is an optimum diameter of approximately 100 m that yields the highest covering power and the most neutral tone. Higher covering power can be obtained using prolate spheroids having a diameter of 40 nm and a length of about twice that. However, as the aspect ratio of the spheroid increases beyond this, the covering power decreases fairly rapidly, thus suggesting that isolated filaments are not optimal. Finally, the results using clusters of spheres suggest that when the spheres are packed close together the covering power can be greater than that of an isolated sphere containing the same volume of silver as the cluster