Nanodiamond Particles' Photothermal Properties in Agarose Gel

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Abstract

The photothermal properties of carboxylated nanodiamond (C-ND) particles in agarose gel base medium were experimentally investigated within a remarkably small volume percentage range: 6.55×10^{-5} - 2.29×10^{-2}% (v/v) and two distinct particle sizes. Compared to base gels, laser-induced spot heating of gels containing trace concentrations of C-ND particles resulted in a significant increase in temperatures distant from the spot. These increases contradicted any thermal conductivity (TC) increases related to particle inclusion. Investigation of the UV-visible and Raman spectroscopies reveals that the considerable particle concentration as well as size-dependent changes in the optical scattering of particulate gels lead to this photothermal phenomenon. C-ND particles attach to the agarose polymer structure, resulting in enhanced optical scattering and entrapment in particle-laden gels, according to structural analysis of the gels. We find that the inclusion of minimal amounts of nanodiamond particles in agarose gels results in structural modifications that highly influence the light scattering and trapping characteristics of the particulate gels. This finding proves that the rate and volume of heating could be controlled based on the intended application. The observed scattering/entrapment has a substantial effect on the photothermal characteristics of these gels, which have wide-ranging applications, including the ablation of tumors and photoelectronic materials.