Terahertz Spectroscopy for the Characterization of Microdiamond and Nano-Onion Particles

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Terahertz (THz) spectroscopy of onion-like carbon (OLC) and high pressure, high temperature (HPHT) synthetic diamond particles has been has been performed to investigate their viability as carbon based biological contrast agents for THz imaging. An effective contrast agent needs to be capable of enhancing the inherent differences in optical properties found between healthy and cancerous breast tissue when illuminated with a THz signal. Two sizes of OLC (100-200nm) and five sizes of HPHT diamond particles (1-150μm) were tested in order to determine what role, if any, the size of the particles has on their effectiveness as a contrast agent. Moreover, three types of diamond particles were tested: pristine particles, particles containing induced lattice defects (vacancies), and particles containing optically active color centers which impart fluorescence. Spectroscopy of the particles was performed by characterizing polyethylene tablets containing either 1 or 10 wt.% of the particles and observing the resultant increase in refractive index and absorption coefficient as compared to pure polyethylene. The spectroscopy was performed using the pulsed terahertz system at the University of Arkansas in its transmission spectroscopy mode. While this system is capable of producing radiation up to 4THz, spectroscopy results for the tablets were only obtained up to 3.5THz due to their attenuation of the signal at higher frequencies. In order to gauge the effectiveness of these particles when incorporated into a lossy medium, the particles were embedded into a phantom material which mimics the THz optical properties of invasive ductal carcinoma. While the spectroscopy results were only obtained up to 2THz in this case, due to the high absorption of the phantom material on the signal, the results demonstrate the potential of the particles to act as a THz imaging contrast agent with the OLC particles showing the greatest potential.