FTIR-BASED SPECTROSCOPY OF DNA PHONON MODES WITHIN BIOLOGICAL AGENTS AT SUBMILLIMETER WAVE FREQUENCIES

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Previous experimental investigations have suggested that long-wavelength vibrations of DNA chains may offer a novel approach for the identification and interrogation of biological agents [1]. While the observed resonant modes of the spectra are very broad, due to both phonon decay and higher order scattering within the DNA lattice, there appears to be sufficient uniqueness for identification of the samples at submillimeter-wave frequencies. These studies utilized Fourier-Transform Infrared (FTIR) spectroscopy to extract absorption coefficient spectra of thick DNA films (e.g. salmon and herring) in the spectral range from 150 GHz to 100 THz. These results were compared to complete cellular agents such the spore bacillus subtillis. In this work, uniform DNA films (50-300 microns) were produced by drying aqueous DNA gels between teflon films. Films of various thicknesses were studied to confirm that the observed resonances were directly attributable to the absorption characteristics of the biological material. The observed results include multiple transitions and demonstrate a sharp increase of absorption with frequency in the range 150-500 GHz. The absorption peaks in the long wavelength limit are related to different branches of acoustic vibrations with a linear dispersion law. Earlier theoretical studies [2] indicate that the weak DNA base-pair bonds interact with the ladder chains to produce these broad lower frequency resonances. In addition, the various samples exhibit unique absorption peaks within this part of the submillimeter region. This contrasts with results from the FIR regime (i.e. 50-100 THz) in which the different DNA samples show very similar spectral features. Hence, this work indicates the presence of distinct and unique spectral features associated with DNA samples in the submillimeter-wave regime. [1] D.L. Woolard, et. al. J. Appl. Toxicology, 17, 243-246, (1997). [2] L.L. Van Zandt and V.K. Saxena, J. Biomol. Struc. Dyn., 11, 1149 (1994).