Investigation of boson peak and fracton in protein lysozyme by terahertz time-domain spectroscopy

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Abstract

Terahertz time-domain spectroscopy and low-frequency Raman scattering have been performed on protein hen egg white lysozyme to investigate the boson peak (BP) and fracton dynamics. The BP dynamics is a universal feature in the glassy states and the fracton dynamics is a universal feature of polymer glass materials. In the $\alpha(v)/2$ plot of the infrared spectrum, where $\alpha(v)$ is absorption coefficient, the boson peak of lysozyme was detected at about 0.58 THz at room temperature. In Raman spectrum, the BP was observed at about 0.82 THz at room temperature from Raman susceptibility divided frequency. Neither the imaginary part of complex dielectric constant nor Raman susceptibility shows absorption peak around their BP frequencies. In the frequency region above the BP, the fracton behavior has been observed both in the infrared and Raman spectrum of lysozyme. The fracton region has a frequency range from 0.58 THz to 3.3 THz in the infrared spectrum, and 0.82 THz to 2.6 THz in the case of Raman spectrum.

Keywords: Boson peak, fractal dynamics, terahertz time domain spectroscopy, protein

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