OBSERVATION OF COHERENT PHONONS IN SINGLE-WALLED CARBON NANOTUBES AND GRAPHENE

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We present a real-time observation of coherent optical phonons in single-walled carbon nanotubes(SWNTs) and graphene. It is important to understand the dynamics of optical phonons in those materials. By using the pump-probe techniques with femtosecond laser pulses, generation and detection of coherent phonons in SWNTs and graphene have been studied. In these graphitic materials the most prominent phonon modes are the so-called G-modes having a 21 fs phonon period. For generation of the high frequency phonon mode, we built up a Ti:sapphire laser with a 12 fs of pulse duration which is shorter than the phonon period. The generation mechanisms of coherent phonons are explained as Impulsive stimulated Raman scattering (ISRS) process. For the detection methods, coherent G-mode phonons in single-walled carbon nanotubes (SWNTs) are investigated through stimulated Stokes and anti-Stokes Raman scattering process by performing spectrum-resolved detection, while coherent G-mode phonons in graphene films are observed by measuring the induced reflectivity changes according to the electro-optic effect.

Since SWNTs are the tubular form, the radial breathing mode (RBM) vibrating in diameter direction is additionally occurred. By analyzing the resonant frequency and resonant energy of the RBM, one can define the diameter and the chirality of the nanotube. It is difficult to investigate a specific chirality in an ensemble SWNT samples. By using a pulse-shaping technique, we have achieved a specific chirality-selective excitation of coherent RBM phonons in ensemble SWNT samples. This gives us to obtain the phase information and the modulation of the absorption in response to the pump pulse.