Symposium W

Phonons in Nanomaterials – Theory, Experiments, and Applications

The Symposium included eleven sessions over a period of five days: Nov 28 – Dec 2, 2011. A total of 99 contributions were made, including 19 Invited talks, 67 contributed talks, and 13 poster presentations. The main theme of the Symposium was to discuss progress made in measuring and theoretically determining phonon modes and their interactions in nanomaterials, and ways in which acoustic wave propagation and phonon transport could be manipulated for advanced applications.

Theory:
The theory of phonon modes in nanomaterials was discussed at the continuum and atomic levels. The continuum theory was presented and applied to discuss long wavelength phonon modes in thin films, quantum dots, and quantum wires. Phenomenological interatomic force models were employed to discuss phonon modes in porous silicon and germanium. The fully ab-inito density-functional perturbation theory was applied to obtain full phonon spectra for bulk and nanostructured semiconductors. The Symposium discussed the progress made in understanding phonon interactions with defects, interface roughness, and anharmonicity. Attempt was made to deal with the complicated anharmonic phonon interaction by employing the fully ab-inito density-functional perturbation theory. Phonon transport was discussed at several levels, including classical molecular dynamics, quantum molecular dynamics, and semi-classical phonon Boltzmann transport theory within the single-mode and effective-mode relaxation times theories. Heat transport in nanostructured semiconductors, graphene and graphene-insulator interfaces was discussed.

Experiments:
The Symposium discussed several aspects of experimental works on phonons in nanomaterials. Application of the Raman scattering method was employed to detect zone-centre phonon modes and the inelastic thermal neutron scattering technique was employed for the mapping of phonon spectrum throughout the momentum space. The Raman and time-resolved Raman thermography techniques were employed for assessing interface quality. Techniques were presented for the generation of coherent phonons. Applications of the picosecond and femtosecond phonon spectroscopies were presented. Several applications of the pump-probe technique were presented. Using this technique hypersonic properties of multi-layer systems were presented. The time-domain thermoreflectance version of this technique was employed to study phonon transport across solid-sold interfaces, a long-standing and extremely complex phenomenon. Using the pump-probe method, the propagation of surface acoustic waves were generated and ultrafast dynamics at surfaces monitored.

Applications:
The Symposium discussed the important role of phonons in enhancing the thermoelectric figure of merit in nanostructured semiconductors. The pump-probe method was applied to measure the thermal conductivity of thin films. Advanced techniques for nanothermal metrology were discussed. Terahertz acousto-electric field in semiconductor nano-devices were discussed. The role of phonons in understanding the performance and reliability of electronics was also discussed.

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