



experimental results: direct absorption measurement, multi-exciton contribution through time-resolved photoluminescence, linear dependence of photolumi-

nescence intensity on excitation energy at threshold levels, and a very low QD-VCSEL threshold.

The researchers said that their results

represent a significant step toward full-color, single-material lasers.

Rosalía Serna

News

Materials Researchers

Mildred S. Dresselhaus receives Kavli Nanoscience Prize



Mildred S. Dresselhaus of the Massachusetts Institute of Technology has received the 2012 Kavli Prize in Nanoscience “for her pioneering contributions to the study of phonons, electron–phonon interactions, and thermal transport in nanostructures.” For more than five decades, Dresselhaus has made multiple advances in helping to explain why the properties of materials structured at the nanoscale can vary significantly from those of the same materials at larger dimensions.

As early as the 1960s, Dresselhaus led one of the first groups that explored carbon materials that form the basis for two-dimensional (2D) graphene and one-dimensional carbon nanotubes. These early experiments helped to map out the electronic band structure of these materials, critical to further understanding the unique properties they might possess. Dresselhaus studied intercalated 2D graphene sheets and provided important insights into the properties of not only

2D graphene, but also of the interactions between graphene and the surrounding materials. Her early work on carbon fibers, beginning in the 1980s, provided Dresselhaus with the understanding and perspective to postulate the existence and unusual attributes of 1D “single-walled carbon nanotubes (SWNTs)” years in advance of their actual discovery. A key prediction included the possibility that SWNTs could behave as either a metal or a semiconductor, depending on the chirality. Dresselhaus and co-workers said that nanotubes can be viewed as arising from the folding of a single sheet of carbon. They showed that this rearrangement of their structure controlled their properties. Through her studies of the fundamental physics of carbon-based solids, Dresselhaus laid the foundation for knowledge that has been integral to today’s nanoscience of carbon.

Dresselhaus studied the transport and optical properties of nanostructured matter through experimental techniques providing unprecedented microscopic understanding. Regarding carbon nanostructures, she pioneered Raman spectroscopy as a sensitive tool for the characterization of materials one atomic layer in wall thickness, namely carbon nanotubes and graphene. Diameter selective resonance enhancement led to the observation of Raman spectra from one single nanotube. The high sensitivity of Raman spectroscopy to diameter and chirality made the technique the prime method for the characterization of carbon nanotubes.

Materials are held together by electrons shared between atoms. When the energy of an electron in a solid is al-

tered, the local bonding of the solid is perturbed, resulting in a change in the position of the atoms that make up the solid. In nanoscale materials, the spatial extent of electrons and phonons can be modulated, leading to dramatically different behaviors compared with extended solids. Dresselhaus has investigated this fundamental electron–phonon interaction in nanostructures using Raman and resonance Raman spectroscopy.

This science also laid a foundation for practical work today aimed at controlling how energy flows. Thermoelectric materials have the ability to convert heat energy to an electrical signal or, alternatively, to utilize electrical energy to actively cool a material. Nature provides materials in which the electrical and thermal conductivity are strongly linked, resulting in a seeming limit to the achievable efficiency of a thermoelectric material. Dresselhaus demonstrated that in a 1D structure, it is possible to separately adjust electrical and thermal conductivity, and that this should allow the creation of new generations of thermoelectric refrigerators and new ways of scavenging waste heat for useful purposes.

The Kavli Prizes recognize scientists for their seminal advances in three research areas: astrophysics, nanoscience, and neuroscience. Consisting of a scroll, medal, and cash award of one million dollars, a prize in each of these areas has been awarded biennially since 2008. The Kavli Prize is a partnership between the Norwegian Academy of Science and Letters, the Kavli Foundation (USA), and the Norwegian Ministry of Education and Research. □



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