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Quantum engineering of semiconductor atomic structures

Nature offers us different kinds of atoms, but it takes human intelligence to put them together in an elegant way in order to realize functional structures not found in nature. The so-called III-V semiconductors are made of atoms from columns III (boron, aluminium, gallium, indium, and thallium) and columns V (nitrogen, phosphorus, arsenic, antimony, and bismuth) of the periodic table, and constitute a particularly rich variety of compounds with many useful optical and electronic properties. Guided by highly accurate simulations of the electronic structure, modern semiconductor optoelectronic devices are literally made atom by atom using advanced growth technology such as Molecular Beam Epitaxy (MBE) and Metal Organic Chemical Vapor Deposition (MOCVD). Recent breakthroughs have brought quantum engineering to an unprecedented level, creating light detectors and emitters over an extremely wide spectral range from 0.2 μm to 300 μm. Nitrogen serves as the best column V element for the short wavelength side of the electromagnetic spectrum, where we have demonstrated III-nitride light emitting diodes and photo detectors in the deep ultraviolet (UV) to visible wavelengths. In the infrared, III-V compounds using nitrogen, phosphorus, arsenic, and antimony from column V, and aluminium, gallium, and thallium from column III elements can create interband and intersuband lasers and detectors based on quantum well (QW), quantum-dot (QD) or type-II superlattice (T2SL). These are fast becoming the choice of technology in crucial applications such as environmental monitoring and space exploration. Last but not the least, on the far-infrared end of the electromagnetic spectrum, also known as the terahertz (THz) region, III-V semiconductors offer a unique solution of generating THz waves in a compact device at room temperature. Continued effort is being devoted to all of the above mentioned areas with the intention to develop smart technologies that meet the current challenges in environment, health, security, and energy. This talk will highlight my contributions to the world of Optics using III-V semiconductor optoelectronics, including devices from deep UV to THz.

Biography

Manijeh Razeghi is Walter P. Murphy Professor and Director of the Center for Quantum Devices. Her current research interest is in nanoscale optoelectronic quantum devices. She has authored or coauthored more than 1000 papers, more than 30 book chapters, and 16 books. She received the IBM Europe Science and Technology Prize in 1987, the Achievement Award from the SWE in 1995, the R.F. Bunshah Award in 2004 and many best paper awards. Razeghi is an elected fellow of SWE (1995), SPIE (2000), IEC (2003), OSA (2004), APS (2004) IOP (2005), IEEE (2005), and MRS (2008).

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