QPhysics AT QUEENS COLLEGE

Colloquium Notice

Maria Tamargo

City College of CUNY

Engineered semiconductor nanostructures for enhanced materials properties

The thrust of the research efforts at the Molecular Beam Epitaxy (MBE) Lab at CCNY is the development of novel semiconductor nanostructures that offer enhanced materials properties for new device applications and physical phenomena. Two areas on which we have focused during the past few years have been the growth of multi-quantum well structures for intersubband (ISB) devices and the growth of submonolayer type II – quantum dots for enhanced p-type doping of difficult to dope materials. I will describe our recent advances in these two areas. Quantum cascade (QC) lasers are a novel semiconductor laser that relies on ISB transitions. They exhibit many unique advantages over the more typical interband devices, including large independence from materials parameters to tune the emission wavelength, ultra-fast response, and the use of uni-polar structures. In order to reach shorter wavelengths in the IR, which is needed for many sensing applications, we have begun to explore the use of wide bandgap II-VI semiconductors for QC laser applications. We have recently demonstrated QC emission form ZnCdMgSe-based heterostructures, and are actively pursuing lasing. Se-based wide bandgap II-VI's are notoriously difficult to dope p-type, as is the case with many other wide bandgap semiconductors. By contrast, ZnTe is easily doped p-type, while n-type ZnTe is not readily achieved. We recently demonstrated a novel approach by which small doped nanoclusters of ZnTe embedded in a ZnSe matrix produce a new composite material in which p-type doping is enhanced by an order of magnitude compared to that of ZnSe. Other properties, such as band gap of the material are not significantly changed. We have carried out a broad range of experiments to understand the mechanism and elucidate the properties of this new nanocomposite material. Other potential applications, such as photovoltaics, have become apparent from our studies.

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