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Pulsed laser fabrication of nanostructures for solar energy and biochemical detector utilization

Branislav Vlahovic

North Carolina Central University, USA

Abstract

Nanoscale materials improve detectors sensitivity, increase device efficiencies, and enable novel designs with low manufacturing costs. For instance, QDs in the strong quantum confinement regime exhibit size tunable bandgaps, large absorption cross sections, and multiple exciton generation that can be exploited to improve photovoltaic conversion efficiencies or detector selectivity. NWs with small diameters possess many of the same properties, and can also strongly trap incident solar radiation. However, QD based devices to date have largely been produced using a narrow range of group IV and III-V semiconductors, through conventional strain induced growth techniques, resulting in QDs that exhibit large lateral sizes and compositional gradients.

Experimental system available at NCCU includes ultrafast pulsed laser deposition and pulsed electron deposition that are enhanced with pulsed free electron laser deposition at nearby Duke FEL facility. It allows for rapid synthesis of a wide range of semiconductor QDs and NW, to establish composition – property relationships. We produce group IV (Si_xGe_{1-x}), III-V (InAs, $In_xGa_{1-x}As$, $GaAs_xSb_{1-x}$) and chalcopyrite ($CuInSe_2$, $CuInTe_2$, $ZnSiAs_2$ and $ZnSiSb_2$) QDs and NWs by ultrafast pulsed beam techniques from bulk targets. We have deposited size controlled QDs, with size dispersions matching those exhibited by conventionally grown QDs, that can be deposited at low temperatures on substrates free of lattice mismatching constraints. QDs are formed with sizes ranging from the strong quantum confinement regime (< 5 nm) to QDs with lateral sizes similar to conventional strain induced growth QDs, through adjustment of the laser fluence, pulse duration and shape, wavelength, and backing gas pressure.

Biography

Branislav Vlahovic is director of the National Science Foundation Computational Center of Research Excellence and director of the NASA University Research Center for Aerospace Device at North Carolina Central University. In 2004, he was awarded by the Board of Governors of The University of North Carolina Oliver Max Garden statewide award for his research and contribution to science. He has published more than 250 papers in peer reviewed journals.