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Continuous-wave pumped lasing using colloidal CdSe quantum wells

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An intense search for colloidal nanocrystal (NC) based continuous-wave (CW) pumped lasers have been ongoing since the observation of optical gain in CdSe quantum dots in the year 2000. However, progress was hampered by efficient Auger recombination in strongly confined spherical quantum dots, which directed the research efforts toward single-exciton gain and CdSe/CdS quasi-type II giant-shell NCs with reduced Auger recombination. An alternative solution exists in the form of 2D CdSe nanoplates, or colloidal quantum wells (CQWells). Here Auger recombination is also strongly suppressed due to stricter momentum conservation rules, as well as a faster (sub-ns) intrinsic exciton (and thus biexciton) recombination rate. Indeed, we measured the single exciton and biexciton time-resolved photoluminescence decay of 515 nm emitting CQWells, and found lifetimes of 438 ps and 124 ps, respectively, indicating a negligible contribution from Auger recombination. As a result, we observed efficient stimulated emission (SE) under femtosecond pulsed and even continuous wave pumping conditions. The SE spectrum peaks at 530 nm, strongly red shifted from the exciton absorption peak and consistent with SE arising from a biexciton population. When we enclosed a 44 um CdSe CQWell film by 2 Bragg mirrors, we even obtained CW pumped multi-mode lasing. These achievements bring solution-processed lasing devices an important step closer to practical applications.

Biography

Joel obtained his PhD in Physics at Wake Forest University in 2012 where he studied the fundamental causes of intrinsic energy resolution degradation in materials used for high-energy detection (thesis: Experimental and Computational Studies of Nonlinear Quenching in Materials used as Radiation Detectors).Following his PhD, he continued as a postdoc at WFU from 2012-2013 in collaboration with Lawrence Berkeley National Lab, Pacific Northwest National Lab, and Fisk University. He has BSc degrees in Mathematics and Ag. and Biological Engineering from the Pennsylvania State University. Joel Grim joined the Nanocrystal Photonics Lab within the Department of Nanochemistry at the Italian Institute of Technology in September, 2013. His postdoctoral research centers on investigating the optoelectronic properties of zero-, one-, and two-dimensional shape-controlled colloidal nanocrystals using ultrafast and nonlinear optical techniques. In addition to fundamental studies of the effects of the various quantum-confinement regimes on carrier dynamics and ultimately light emission, he is also pursuing various photonic applications.

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