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Site-controlled quantum dots and their integration in photonic crystal nanocavities

Giorgio Pettinari
IFN-CNR, Italy

The fabrication of integrated quantum dot (QD)-optical microcavity systems is a requisite step for the realization of a wide range of nanophotonic experiments and applications that exploit the ability of QDs to emit non-classical light, e.g., single photons. Here, we present the possibility of creating site-controlled QDs in dilute-nitride semiconductors by spatially selective H incorporation and/or removal. In dilute nitrides (e.g., GaAsN), the formation of stable N-2H-H complexes following H incorporation removes the effects nitrogen has on the alloy properties. In particular, H binding to N atoms in GaAsN leads to an increase in the band gap energy of the GaAsN (~1.33 eV for [N]=1% at T=5 K) up to the value it has in GaAs (1.52 eV at 5 K). Therefore, by engineering the spatial H incorporation and/or removal in dilute nitrides is possible to attain a spatially controlled modulation of the band gap energy in the growth plane and therefore, to tailor the carrier-confining potential down to a nm scale, resulting in the fabrication of site-controlled QDs. Clear evidence of single-photon emission is presented for QDs made either by low-energy H irradiation of lithographically prepatterned samples and by spatial H removal in a fully hydrogenated sample by using the near-field hot spot generated by a SNOM tip to locally break the N-H bonds. Also, a lithographic approach to the deterministic QD-PhC nanocavity coupling is demonstrated, resulting in a significant enhancement (inhibition) of the spontaneous emission rate for low (high) cavity mode (CM)-QD energy detuning (Purcell effect).

Biography

Giorgio Pettinari has completed his PhD in Materials Science from Sapienza University of Rome in 2008. From 2009 to 2011, he has worked as Assistant Researcher in High Field Magnet Laboratory (HFML) of Nijmegen (The Netherlands), then (2011-2013) he moved to The University of Nottingham (UK) as Marie Curie Research Fellow. Since 2013, he is a Researcher at Institute of Photonics and Nanotechnologies (IFN-CNR) of National Research Council of Italy. He has published more than 35 peer-reviewed original papers in academic journals, 2 invited book chapters and given more than 15 oral contributions and seminars (5 invited) at international conferences and research institutes.

giorgio.pettinari@cnr.it

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