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Biography

Giorgio Pettinari is a researcher at the Institute of Photonics and Nanotechnologies of the National Research Council of Italy. He got a PhD in materials science from Sapienza University of Rome (Italy, 2008) and was an assistant researcher at High Field Magnet Laboratory of the Radboud University of Nijmegen (The Netherlands, 2009-2011) and a Marie Curie Research Fellow at the University of Nottingham (UK, 2011-2013). His interests range from the experimental investigation of semiconductor nanostructures to micro- and nano-fabrication and investigation of innovative photonic and plasmonic devices. Recently, he developed a novel strategy for the post-growth fabrication of site-controlled, single-photon emitting quantum dots. Pettinari published more than 40 peer-reviewed original papers in academic journals (among which 2 invited review papers), 2 invited book chapters, and he given more than 20 oral contributions and seminars (7 invited) at international conferences and research institutes.

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NOVEL STRATEGIES FOR SITE-CONTROLLED QUANTUM EMITTER FABRICATION

Many of the most advanced applications of semiconductor quantum dots (QDs) in quantum information technology require a fine control of the QDs' position and confinement potential, which are hardly to be achieved with conventional growth techniques. Here, a novel and versatile approach for the post-growth fabrication of site-controlled QDs is presented based on a spatially selective incorporation or removal of hydrogen atoms in dilute nitride structures. Hydrogen incorporation in GaAsN results, indeed, in the formation of N–H complexes that neutralize all the effects of N on GaAs, including the N-induced large reduction of the bandgap energy. Therefore, by engineering the spatial incorporation and/or removal of hydrogen in dilute nitrides it is possible to attain a spatially controlled modulation of the bandgap energy in the growth plane and, eventually, to tailor the carrier-confining potential down to a nm scale, resulting in the fabrication of site-controlled QDs that are able to emit single photons on demand.

Two different fabrication approaches have been developed to control spatially the hydrogen incorporation and removal in the system: either a lithographic-based technique for defining hydrogen opaque masks for the spatial control of hydrogen incorporation and a laser-assisted spatially selective hydrogen removal technique that takes advantage of a local N–H complex dissociation induced within the light spot generated by a scanning near-field optical microscope. Both techniques relies on the peculiar ultra-sharp diffusion profile of hydrogen in dilute nitrides and allow a control on the hydrogen implantation and/or removal on a nanometer scale. This novel fabrication technique feature state-of-the-art position accuracy (up to 20 nm) as well as a fine control on the emission energy of the realized QDs. The strategy for a deterministic spatial and spectral coupling of such quantum emitters with photonic crystal cavities has been also developed.

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