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Erbium and silicon nanocrystals-based light emitting devices for lightwave circuits

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Abstract

In the present work electroluminescence and transport properties of silicon nanocrystals based devices are studied. The talk will be divided into two main topics: silicon nanocrystals (Si-NCs) based light emitting diodes (LEDs) and Er^{3+} doped silicon nanocrystals devices.

In the first part of the talk, I will present the fabrication and the characterization of Si-NCs based LEDs. Devices produced by different batches and different layouts are studied and compared in terms of structural properties, conduction mechanisms and electroluminescence properties. I will discuss current-voltage, capacitance-voltage characteristics and time resolved electroluminescence measurements. Power efficiency was evaluated and studied in order to understand the relation between the exciton recombination mechanisms and the electrical conduction. Moreover, the time dependence of the electroluminescence has been studied, clarifying the role of bipolar or unipolar injection in these structures.

On the second part of the talk I will present my work on Er^{3+} and Si-NCs co-doped devices. Firstly, the study was aimed at the understanding of the efficiency of the electrical pumping of Er^{3+} ions. Then, integrated optical cavities have been designed and fabricated and their optoelectronic properties measured. Here I fixed a specific experimental set-up in order to measure at the same time the optical and the electronic properties of the active devices on the silicon wafer. Unfortunately, the measurements demonstrated that many nonlinear loss mechanisms set in when the devices are heavily injected with current. Moreover, I have demonstrated a fully integrated system where the Er^{3+} doped injection device pumps a waveguide and the emission is then extracted through a grating. Last result was the experimental verification of the existence of intermediate band states through which the silicon nanocrystals to Er^{3+} energy transfer occurs.

Finally, I will discuss future directions for research in silicon based light emitting devices and I will report a brief outlook for silicon nanocrystals based devices in the silicon photonics scenario.

The speaker

Andrea Tengattini graduated in Physics in 2010 at the University of Torino with a Thesis on radiation damage effects on epitaxial silicon devices. Subsequently, in 2013 he obtained a PhD in Physics at the University of Trento, with a Thesis on erbium and silicon nanocrystal-based light emitting devices. He is currently a post-doc grant holder at the Nanoscience Laboratory of the Department of Physics of the University of Trento. Dr. Tengattini has an extensive expertise on silicon-based optoelectronic devices, as demonstrated by a prolific scientific production on the subject in the framework of several European projects.