Silicon Nanostructures for Photonics, Photovoltaics and Sensing

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Recent efforts on the fabrication of silicon nanostructures for applications in photonics, photovoltaics and sensing will be reviewed [1-3]. Silicon nanophotonics is emerging as a new platform for the integration of photonic and electronic devices. Several examples of recent efforts on monolithic light sources based on silicon nanostructures will be presented and discussed. In particular it will be shown that silicon-on-insulator (SOI) is emerging as an interesting photonic material. The first electrically pumped silicon-on-insulator nano light source, tunable around 1300-1600nm range and operating at room temperature will be presented. Alternatively rare earth ions are introduced into a nanocavity showing an enhanced emission with potentials for a population inversion and laser action. Group-IV semiconductor nanowires (NWs) are also attracting interest among the scientific community as building blocks for a wide range of future nanoscaled devices. We show that metal-assisted chemical etching is a powerful technique to obtain nanometer-size high density and low-cost Si NWs with high and controllable aspect ratio. We will show that luminescence is very efficient (in the order of the percent) and tunable with NWs size according to quantum confinement. These structures show remarkable Raman properties and behave also as black absorbers. Their potentials for the fabrication of novel solar cell as well as for biosensing will be presented. The relevance and the perspectives of the reported results opening the route towards novel applications of Si nanostructures in photonics, photovoltaics and sensing will be discussed.

[1] F. Priolo, T. Gregorkiewicz, M. Galli, T.F. Krauss, *Silicon Nanostructures for Photonics and Photovoltaics*, Nature Nanotechnology **9**, 19 (2014)
[2] Fazio et al., *Strongly enhanced light trapping in a two-dimensional silicon nanowire random fractal array*. Light: Science & Applications, **5**, e16062 (2016)
[3] Fazio et al., *Coherent backscattering of Raman light*. Nature Photonics **11**, 170 (2017)