Optical Properties of Silicon Nanowires-Based Composites

Yury V. Ryabchikov

HiLASE Centre, Institute of Physics of the Czech Academy of Sciences,
Scientific Laser Application Department, 828 Za Radnicí, Dolní Břežany, Czech Republic

Nanostructured silicon represent a great class of nanomaterials including various nanostructures such as porous silicon, silicon nanowires, silicon (oxy-)nitride, silicon carbide, silicon nanoparticles formed by pyrolysis, chemical etching or pulsed laser ablation techniques. Formation of low-dimensional materials reveal new unique structural and optical properties as compared to bulk silicon significantly depending on a type of a silicon wafer, used treatment procedure, nanostructuring conditions etc.

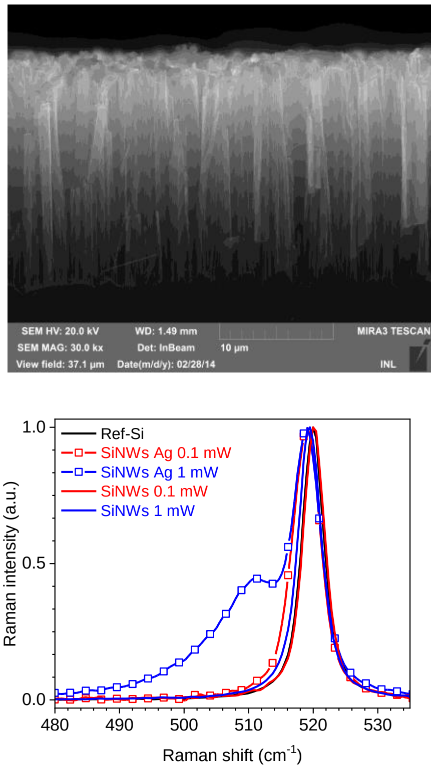

Figure 1. SEM image (on the top) and Raman shift (on the bottom) of Si NWs with and without Ag nanostructures at different laser power (488 nm).

One of the perspective candidates is silicon nanowires (Si NWs) formed by metal-assisted chemical etching of a bulk silicon wafer possessing highly aligned structure of silicon nanocrystals contrary to chaotic one in porous silicon films. It leads to more homogeneous and reproducible structural and optical properties of Si NWs that can be employed for photovoltaic, sensing or biomedical applications. Moreover, highly ordered porous structure of Si NWs makes them a nice matrix for introducing of different kinds of fluorophores, including other types of Si-based nanomaterials, in order to develop multifunctional nanoplatforms.

In this research, Si NWs were formed using different time of chemical etching (from 15 s to 30 min) and their properties were investigated. In particular, Si NWs possess considerable Raman shift at 520 cm^{-1} using various excitation wavelengths at the visible spectral range followed by some signal distortion with the increase of the laser power making Si NWs perspective for optical nanothermometry. Moreover, Si NWs also reveal some PL variable in the range of 600 – 700 nm depending on the used excitation wavelength (343 – 515 nm). Furthermore, introducing of silicon or silicon carbide nanoparticles formed by the chemical etching leads to some spectral shift of the maximum position of Si NWs photoluminescence as well as its intensity.

Thus, optical properties of Si NWs can be varied not only by changing of the synthesis conditions but also by introducing of different silicon-based nanostructures in pores of Si NWs matrix forming silicon composite material.

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