Facile Synthesis of Semiconductor Nanostructures with Variable Plasmonic Properties Using Pulsed Laser Ablation Technique

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

Different semiconductor nanostructures such as silicon or carbon nanoparticles are promising nanomaterials in many various applications such linear or nonlinear bioimaging, optical nanothermometry, gas sensing, radio-frequency-induced hyperthermia etc. However, their simultaneous applications in different applications can be considerably limited due to the absence of specific features related to noble metal or magnetic metals. Thus, merging of semiconductor nanostructures with various metallic elements in the form of one nanoparticle by designing of multielement nanocomposites can significantly enlarge the application area of semiconductor nanomaterials.

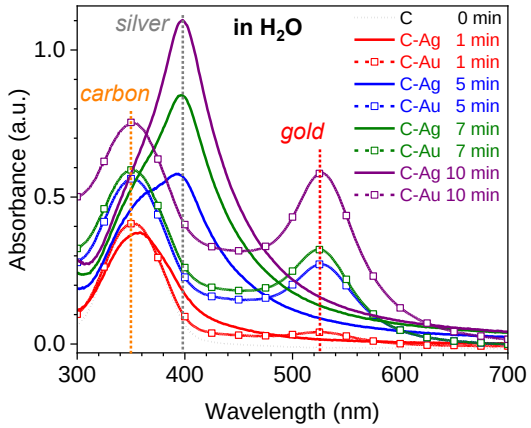

Figure 1. Laser ablation time-dependent plasmonic properties of fluorescent carbon nanocomposites with tuneable plasmonic properties.

In this work, the synthesis of various composite semiconductor-based nanoparticles with variable both efficiency and spectral position of their plasmonic properties was carried out by pulsed laser ablation in liquids (PLALs) techniques providing a facile formation of multi-element nanostructures of high chemical purity. In particular, carbon and silicon nanoparticles with strong linear and nonlinear photoluminescence, respectively, were used for the development of composite nanostructures. The performed laser-induced structural modification of semiconductor nanomaterials provides the strong plasmonic properties whose efficiency can easily be controlled by the laser irradiation time (Figure 1). The structural properties of the synthesized nanocomposites were investigated by different X-ray techniques such as X-ray diffraction (XRD) and X-ray photoelectron spectroscopy (XPS) as well as by electron paramagnetic resonance (EPR). Moreover, an impact of the chemical composition on the emission properties of fluorescence carbon nanodots was studied by the steady-state photoluminescence showing the modification of the fluorescence spectra of carbon nanodots upon the laser ablation time. The performed laser-induced change of the semiconductor nanostructure performance reveals new applications of silicon and carbon nanostructures in the field of nanoplasmonics related to the sensing of different molecules using surface-enhanced effects due to the presence of noble metal elements.

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