Pavle Radovanovic, J Nanomater Mol Nanotechnol 2017, 6:4 (Suppl)
DOI: 10.4172/2324-8777-C1-007

16th World Nano Conference

June 05-06, 2017 Milan, Italy

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Tuning plasmon resonance of In_2O_3 nanocrystals throughout mid-infrared: Dopant, phase, and electronic structure dependence

Synthesis, properties, and applications of gold and silver nanostructures with tunable localized surface plasmon resonances (LSPRs) have been a subject of intense investigation over the past decade. The focus on these noble metal plasmonic nanomaterials stems from their facile synthesis, stability to oxidation, and the visible-range LSPR transitions. However, among other drawbacks, these nanostructures are also costly for large-scale applications and exhibit high optical losses. Consequently, doped transparent metal oxide nanocrystals have emerged as a new class of unconventional plasmonic materials. In this talk, author will present the results of our recent work on colloidal indium oxide-based plasmonic nanocrystals. Using size-structure correlation, indium tin oxide (ITO) nanocrystals were prepared in the stable bixbyite (bcc-ITO) and metastable corundum (rh-ITO) phase, revealing a dramatic difference in their optical and electrical properties. Unlike rh-ITO, bcc-ITO nanocrystals exhibit a strong LSPR absorption in the near-infrared region due to the presence of free electrons, enabled by the low activation energy donor states. Author will also discuss colloidal synthesis and spectroscopic properties of two new plasmonic nano crystal systems based on In_2O_3, antimony and titanium-doped In_2O_3, and comparative investigation of their electronic structure using combined Drude-Lorentz model and density functional theory. Fundamental understanding of the electronic structure and phase-dependent plasmonic properties allowed us to design and prepare plasmonic In_2O_3-based nanocrystals tunable throughout the entire mid-infrared region. Application of these colloidal mid-IR plasmonic nanocrystals will also be discussed.

Biography

Pavle Radovanovic completed his PhD at University of Washington, Seattle. Following his Post-doctoral studies at Harvard University, he started his independent research career at University of Waterloo in 2006. At Waterloo, he initiated a new research program in Physical-inorganic Chemistry focusing on “The design, synthesis, and fundamental physical and chemical properties of multifunctional low-dimensional materials”. His work has been recognized by number of honors and awards, including Canada Research Chair (NSERC), Early Researcher Award (Ontario Ministry of Research and Innovation), Mobility Award (French Ministry of Foreign Affairs), and CNC-IUPAC Award.

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