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Promising features of Au nanoparticles on near-infrared photoluminescence from Si/SiGe other than LSPR

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Au nanoparticles (NPs) have attracted broad attentions thanks to their superior capability to modify the optical, the electrical and the thermal properties of the surrounding medium. All those unique features and various applications of Au NPs are mainly based on the strong interaction with resonant photons through localized surface Plasmon resonance (LSPR). A question naturally arises whether the Au NPs can also remarkably modulate the properties of the surrounding median under the off-resonant excitation. In this report, the Si/SiGe hetero-structures are grown on Si (001) substrates by molecular beam epitaxy (MBE). The Au NPs on the Si/SiGe hetero-structures are obtained by annealing an ion-sputtered Au thin film at 400 °C for 30 min in the vacuum. It is found that the PL from the Si and the SiGe is comprehensively modified by the Au NPs under the excitation without the surface Plasmon resonance. Moreover, the PL spectra sensitively depend on the size of the Au NPs, the excitation power and the thickness of Si between the Au NPs and the SiGe, as shown in Figure 1(a). A model is proposed in terms of the electrostatic effect of the naturally charged Au NPs due to the electron transferring through the nano-scale metal/semiconductor Schottky junction without an external bias and an external injection of carriers. It reveals that Au NPs can substantially modify the energy band structures, the distribution and the transition of carriers in the nano-scale region below the Au NPs. Our results demonstrate that the Au NPs on semiconductor can efficiently modulate the light-matter interaction from the fundamental aspect of the matter as well as the light. Such promising electrostatic effects of the metal NPs open an alternative door to design innovative optoelectronic, photo-electrochemical and photo-catalytic devices based on the strong light-matter interaction.

Recent Publications

Y Yin, Z Wang, S Wang, Y Bai, Z Jiang, Z Zhong (2017) Electrostatic effect of Au nanoparticles on near-infrared photoluminescence from Si/SiGe due to nanoscale metal/semiconductor contact. *Nanotechnology*; 28(15).

Biography

Zhenyang Zhong has completed his PhD from Institute of Physics, Chinese Academy of Sciences, Beijing, China and Postdoctoral studies from Johannes Kepler University, Linz, Austria and Max Planck Institute for Solid State Research, Stuttgart, German. He is the Professor in Department of Physics, Fudan University, China. He has published 39 papers in reputed journals and serving as an Editorial Board Member of *Journal of Material Sciences & Engineering*.

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