Title: Ultrafast photoconductivity and charge carrier transport in semiconductor nanostructures: a study by terahertz spectroscopy

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Abstract: The thesis is devoted to a study of charge transport in nanostructured systems by means of time-resolved terahertz spectroscopy. We address various aspects of electron confinement in such systems, and the role of depolarization fields on the effective photoconductive response of samples. Accurate evaluation of localized carrier properties has been achieved using quantum mechanical calculations of the mobility. Theoretical interpretation of the terahertz conductivity spectra is based on the solution of the wave equation for the terahertz wave in inhomogeneous photoexcited media described in terms of VBD effective medium model developed in our laboratory. This approach is employed for investigation of the terahertz photoconductivity in two types of nanomaterials: superlattices of Si nanocrystals prepared by thermal decomposition of SiO_x layers and lithographically prepared GaAs nanobars. Experimental spectra were measured at 300 and 20 K and for a wide range of photocarrier densities. A careful analysis of electron transport in Si nanocrystals showed a broad distribution of the nanocrystal sizes and its dependence on the silicon content. These results are also supported by time-resolved measurements in the far- and mid-infrared range. The investigation of the GaAs nanobars sample revealed a band bending close to the nanobar surface that has been confirmed using time-resolved terahertz near-field experiment.

Keywords: time-resolved terahertz spectroscopy, photoconductivity, charge transport and confinement, depolarization fields, effective medium theory.