Title: Time-resolved spectroscopy of semiconductor nanostructures

Author: RNDr. Miroslav Kořínek

Department: Department of Chemical Physics and Optics

Supervisor: doc. RNDr. František Trojánek, Ph.D., Department of Chemical Physics and Optics, Faculty of Mathematics and Physics, Charles University in Prague

Abstract: This Ph.D. thesis is focused on the study of relaxation and recombination processes in silicon nanocrystals embedded in dielectric (SiO_2, SiC and Si_3N_4) matrices that were fabricated within the EU 7th Framework Programme Silicon Nanodots for Solar Cell Tandem (NASCEnT). Different host materials, in which silicon nanocrystals are incorporated, not only provide different transport properties, but also differently affect the nanocrystal surfaces. A large part of the thesis is devoted to research of SiO_2–embedded silicon nanocrystals having various sizes (in the order of nanometers) and various inter-nanocrystal separation, that differ also in the manner of an additional annealing. Experimental techniques of optical spectroscopy are used to monitor the photoexcited charge carrier dynamics on a wide time scale from picoseconds to milliseconds. The initial (picosecond) dynamics is characterized very well using a relevant rate equation. We propose a theoretical description of how the multiparticle recombination rate depends on the inter-nanocrystal separation. Furthermore, we show that P–type doping with boron and remote plasma hydrogen passivation have a dramatic effect on the recombination of photoexcited charge carriers in SiC–embedded silicon nanocrystals. In the case of silicon nanocrystals embedded in Si_3N_4 matrix, the origin of visible photoluminescence is studied and discussed in detail.

Keywords: nanocrystals, silicon, optical spectroscopy, photoluminescence