Title: Ultrafast spectroscopy of hybrid nanosystems

Author: RNDr. Pavel Galář

Department: Department of Chemical Physics and Optics

Supervisor: prof. RNDr. Petr Malý, DrSc.

Abstract: This Ph. D. thesis is focused on physical phenomena located at the interface of hybrid nanostructure composed of polycrystalline diamond and polymer polypyrrole. The main method used in our experimental study was ultrafast laser spectroscopy that allowed us to gain new findings about electron recombination processes in polycrystalline diamond layers, polypyrrole and in their hybrid structures. The research was focused on mutual influence of both components, especially through energy and charge transfer. In the first step of our research we carried out optical characterisation of different kinds of polypyrrole and complex study of recombination processes dynamics of photoexcited charge carriers in polycrystalline diamond. The measurements were realized by the methods of time-resolved photoluminescence and transmission spectroscopy in the time scale from picoseconds to milliseconds. On the basis of the obtained results the model explaining the origin of luminescence signal related to the different kinds of electron recombination processes in non-diamond phase and on surface defects of diamond grains in polycrystalline layers was created. The thesis also contains similar experimental study carried out on the hybrid that proved influence of the polymer on the recombination processes of excited charge carriers in diamond up to a depth 200 nm far from the interface. Observed modifications of diamond internal properties were interpreted in terms of charge carriers spatial separation caused by the presence of polypyrrole. Additional original result of this work is a discovery of polypyrrole luminescence modification induced by the ultraviolet irradiation. The detailed study of this phenomenon along with its interpretation is also part of this thesis.

Keywords: time-resolved laser spectroscopy, photoluminescence, polycrystalline diamond, polypyrrole, hybrid nanostructures