

Co-director's report on the doctoral thesis of RNDr. Lukáš Ondič

Silicon nanocrystals, photonic structures and optical gain

Doctoral thesis of RNDr. Lukáš Ondič was carried out within the years 2009-2014 in the framework of the joint supervision agreement, called „doctorat en cotutelle“, between the University of Strasbourg (UdS) and Charles University in Prague under the common supervision of Prof. Dr. Bernd Hönerlage from UdS and me. RNDr. Lukáš Ondič draws on more than 20 year's standing collaboration between the Institute of Physics and Chemistry of Materials of Strasbourg and the Institute of Physics, Academy of Sciences of the Czech Republic, v.v.i. Here, he has already been participating on the “Silicon nanophotonics” research programme of the Department of Thin Films and Nanostructures since the beginning of his work on his diploma thesis entitled “Time-resolved measurement of optical gain in silicon-based nanostructures” in 2007.

The subject of the Mr. Ondič's thesis reflects one of the principal courses of current materials research – so called silicon nanophotonics. One of the main objectives in this field is search for an efficient electrically pumped light source (preferably laser) that could be easily integrated onto silicon microelectronic chips. Silicon nanocrystals and nanostructures are promising candidates because of their strong visible luminescence and positive optical gain. However, due to low optical gain coefficients and insufficient optical quality of the material, achieving lasing from silicon nanocrystals remains a challenge.

The aim of the thesis was to investigate a possibility of enhancing the optical gain of light-emitting silicon nanocrystals by combining them with a two-dimensional photonic crystal. This represents quite original approach, merging together up to now two independent research areas – silicon nanophotonics and photonic crystals. After having characterized the properties of silicon nanocrystals and evaluating optical gain, RNDr. Ondič performed computer simulations what allowed him to find the optimal design of the photonic structure which was afterwards fabricated. RNDr. Ondič has proved that the intensity vertically-extracted light from a two-dimensional photonic crystal with embedded silicon nanocrystals can be significantly enhanced (in our case by a factor of 7).

For the whole period RNDr. Lukáš Ondič has been working very purposefully and systematically. Delicate optical measurements of optical gain and photonic band diagrams were carried out very accurately and evidence the author's excellent experimental skills. He independently analyzed and interpreted the obtained results and correlated them with

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simultaneously performed theoretical calculations. The thesis is arranged in the form of 10 commented publications and well-organized. It contains original results that are matter of 12 publications in refereed international journals and 10 presentations at established scientific conferences. Moreover, the RNDr. Ondič's work has been recently awarded by two prestigious prizes for young Czech scientists: 1st prize of the Milan Odehnal's Award organized by the Union of Czech Mathematicians and Physicists in 2012 and Josef Hlávka Award for the best students and graduates of Czech universities in 2013.

To conclude, RNDr. Lukáš Ondič has undoubtedly proved his ability to carry on independent research in physics and his thesis merits to be defended as a Ph.D. thesis.

Prague, January 13th 2014

RNDr. Kateřina Herynková, Ph.D.

Co-director of the thesis