ÚFE Ústav fotoniky a elektroniky
Akademie věd ČR

Evaluation of postgraduate student and review of dissertation thesis

PhD student: Ing. Yauhen Baravets

Thesis title: Periodically poled nonlinear crystals for difference frequency generation of fiber lasers

Supervisor: Dr. Ing. Pavel Honzátko

Advisor: Doc. Ing. Ivan Richter, Dr.

Student evaluation

Yauhen Baravets is skilful and reliable experimental physicist. He harnessed complicated technologies such as ion beam etching, photolithography, special optical fibre cleaving and splicing. He redesigned a low temperature technology of nonlinear optical crystal poling and learned to prepare samples for deposition of metallic and dielectric thin layers. Last but not least he mastered numerous advanced measurement techniques such as atomic force microscopy, scanning electron microscopy, optical and contact surface profiling, and varieties of spectroscopy. Repeatably he demonstrated good physical estimations, predictions, understanding and interpretation of experimental facts. Yauhen had decisive role in experimental investigation of all topics covered in the thesis and also in photolithographical definition of diffractive optical elements which were not included into the thesis but which are subject of publication [P3] and in nanofabrication of antireflection patterns on fibre facets by focused ion beam milling.

Dissertation targets

The scope of the theses is very broad and reflects the topics solved in projects of our research team. It covers areas of fibre lasers, nonlinear optics, and molecular absorption spectroscopy. In particular, it includes

- studies of broadly tunable single frequency fibre lasers,

- broadband amplification of signals

- optimization of poling patterns with the aim to maximize difference frequency generation efficiency over broad spectral range

- harnessing the technology of periodical poling of nonlinear optical crystals

- practical application of broadly tunable mid infrared generator in the high resolution laser spectroscopy.

Selected methods

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In the thesis, state of the art methods are used for achieving single frequency operation of fibre lasers, for investigation of laser stability, for poling of the nonlinear optical crystals. Additionally, the student numerically studied efficiency of the difference frequency generation using the MATLAB FEM toolbox under various focusing conditions in crystals with different poling patterns and independently verified our in-house developed numerical techniques based on the beam propagation method. I appreciate harnessing advanced diagnostic tools such as piezoresponse force microscopy allowing deeper understanding of the process of nonlinear optical crystal poling.

Meaning for science and for practice

The concept of single frequency laser based on the fibre ring resonator filter is further investigated as a possible basis of the laser source for the atomic optical clock which is expected to be next milestone in precision metrology. Broadly tunable mid infrared generator can be used as a reference laser source for spectrometric measurements, and as a basis of optical vector analyser operating in the mid-infrared frequencies. Technology of nonlinear optical crystals poling can be used not only for the difference frequency generation but also for other parametric nonlinear optical processes and serve to sensitive detection, and to conversion of light to wavelengths difficult to reach otherwise.

Publication activity

Results forming the core of the thesis have been published in three peer reviewed scientific journals. Additionally, partial results have been published at 9 international scientific conferences. At majority of them Yauhen was the first and presenting author. Yauhen also contributed to many other projects solved in our laboratory which is reflected by his inclusion in authors list of the references [O1-O21] at pages 84-85 of the thesis. Of these 4 were published in well impacted scientific journals such as Optics Express or Optics Letters.

Final evaluation

The dissertation thesis demonstrates broad scope of the student and his ability to use and develop very complicated technological instruments.

I believe that the dissertation thesis fulfils requirements for the degree of Ph.D. and recommend it for defence.

In Prague 30.9.2020

Dr. Ing. Pavel Honzátko

Supervisor

Institute of Photonics and Electronics of the Czech Academy of Sciences, v. v. i.