Report on the doctoral dissertation

„Optical Properties of Photonic Crystal Fibers Infiltrated with Liquids"

by

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Doctoral dissertation of Mr. Hoang Van Thuy's is devoted to numerical and experimental studies of the optical properties of various liquid core photonics crystal fibers (PCFs). The investigated PCFs were fabricated at the Department of Glass in the Institute of Electronic Materials Technology (ITME) in Warsaw while the experiments and modelling were conducted in the Faculty of Physics of the Warsaw University and Faculty of Electronics and Information Technology, Warsaw University of Technology.

At the beginning of the dissertation the author presents motivation of his work, specifies his own contribution to achieving the objectives of the dissertation and formulates three theses: (*i*) *Silica hollow core PCSs infiltrated with liquids can offer flat all-normal dispersion regime in near-infrared range. The dispersion feature is compatible with central wavelengths of commercially available femtosecond lasers for supercontinuum generation applications;* (*ii*) *Spectrally broad supercontinuum generation can be achieved in hollow core PCSs with liquid infiltration and low-power input pulses;* (*iii*) *Antiresonant fibers infiltrated with low-index liquids offer broadband transmission windows and are suitable for optofluidic systems.*

The second chapter presents theoretical foundations of the dissertation, i.e. the light guiding mechanism in fibers and basic nonlinear phenomena accompanying propagation of strong, short laser light pulses. The next, third, chapter of the work is devoted to modeling of the optical properties of liquids, buffers and cell cultures, with which the photonic optical fibers were infiltrated.

The main research task carried out by the author is described in Chapters 4-6. It concerns the filling of fibers by liquids and studying their optical linear and nonlinear properties, a supercontinuum generation in particular. Chapter 7 presents the results obtained with a large mode area PCF coupled with the liquid core fiber and supercontinuum generation in such a system. Chapter 8 describes results of research with antiresonance fibers filled with various liquids. The dissertation is concluded in Chapter 9 by a short discussion and outlook to the perspectives emerging from the obtained results. The outcome of the doctoral dissertation became the basis for 9 scientific publications in good journals and in 4 conference presentations coauthored by Mr. Hoang Van Thuy. I regard the results presented in the dissertation as very interesting and valuable. They clearly pave the way for innovative applications. The author managed to reached a good balance between numerical and experimental work an demonstrated good acquaintance with the up-to-date optical fiber technology and its applications. I especially liked the part of the work which focused on opto-fluidics and clever use of fiber splicers.

Unfortunately, my high overall assessment of the dissertation's scientific value became seriously lowered by its the bad grammar and editing. In particular, the thesis contains a number of undefined terms and/or quantities which pose quite a challenge to the reader trying to understand their physical meaning. For example, on page 71 an undefined quantity $\tilde{A}$ (A with a tilde) appears, most likely designating the Fourier transforms of A. Also, the notion of a "*dispersive wave*" appears several times on pages 83-88 with no explanation of its meaning.

One of the notions often used in the dissertation without a proper definition is *coherence*. Coherence occurs in physics in a variety of situations, hence it is necessary to define precisely its meaning in a given context. In fact, the author does refer to the notion of coherence and noise, but only in Chapter 6.3, which is too late in my opinion. Speaking of noise, it is defined in Eq. (6.4) as a complex number depending on some undefined phase Φ. I would expect the noise to be characterized by some amplitude averaged over many experimental realizations. Unfortunately, no explanation is given on such averaging. Only in the Figure 6.9 caption there is a note on averaging over 20 pulse pairs but again without clear explanation what is averaged and how.

In my opinion, in the dissertation the basics of nonlinear effects are described too briefly. Specifically, some descriptions of a soliton formation and fission would be very appropriate, such that the relevant nice illustrations would get adequate explanation. A doctoral dissertation should demonstrate a sound general knowledge of a PhD candidate and the ability to present his/her research in a wider context. PhD dissertations are often used as an introductory reading to research and Ph.D. students, hence they should be sufficiently descriptive.

The scattering measurements (Figs. 3.10 and 3.11 on page 50) are very interesting as they clearly show the existence of two contributions originating from the coherent (highly directional) and incoherent (quasi-isotropic) scattering. Unfortunately, there is no comment in the dissertation on that feature. I understand that the light scattering was not a main topic in the author's research, yet the observation of its geometrical properties is very interesting and should be commented in the dissertation, I think.

In conclusion, the author addressed an important and very timely subject in his dissertation. He realized all goals and theses formulated in the beginning of his work. Despite editorial deficiencies and drawbacks listed above, **I assess positively the dissertation of Mr. Hoang Van Thuy and recommend admitting the candidate to further stages of the doctoral procedure**.

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