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Review of PhD thesis of Richard Svejkar

" Erbium-doped diode-pumped solid-state lasers generating in mid-infrared spectral range "

The dissertation of Mr. Richard Svejkar belongs to laser physics and engineering, and partly to material science. The main goal of thesis is the investigation on existing and new Er doped media for diode pumped lasers operating nearly 3-μm wavelength. In the first part (section 2.) of PhD Author presents the comprehensive review of Er doped media and 3-μm Er lasers. The main sections 4. and 5. give a comprehensive guide/review of the well-focused set of eighteen scientific articles and conference papers devoted to this subject, in which Mr. Richard Svejkar was one of the principal authors. The set of papers starts with the review paper in Progress in Quantum Electronics being the summary of Mr. Svejkar's research on this topic, followed by scientific articles and conference reports published in the best journals and conferences in this area of applied physics. The outside the scope of this thesis is a group of 10 scientific papers coauthored by Mr. Svejkar in which the subject of modern mid-infrared lasers has beem considered as well.

These original research works presented in thesis, carried out since 2016 up to 2020 are in my opinion in frontiers of laser physics. Especially, important from the viewpoint of practical applications are results of cw operation up to 3W in Er:YLF laser and the development of two types of compact Er-microchips operating in continuous-wave and gain switching regimes.

The main concept and scientific method, applied with success in this extraordinarily big, regarding to the typical requirements on PhD degree, number of papers, was the experimental research aimed to examine feasibility and properties of several (known as Er:YAG or YAP and lately developed as crystalline Er:SrF_2 or Er:GGAG, and ceramic Er:Y_2O_3) gain media and regimes of laser operation around 3-μm wavelength. The experimental setups, measurement methods and instruments to realize such goals were in my opinion appropriate evidencing high scientific level of supervisor's laboratory and Author itself. As a rule, typical, commercially available laser elements and instruments for spectroscopic and laser characterization were applied. In a case of characterization of mode locking in view of lack of appropriate instruments on market, Author developed his own home-made autocorrelator, evidencing his high laboratory skills. The same can be said on, developed by Author, the computerized environment and laboratory setup to comprehensive control and measurements of laser parameters in cryostat for wide range of temperatures.

The three specific goals of thesis (*i/* investigations of Er: media and lasers, *ii/* generations of short pulses, *iii/* investigation of Er-microchip lasers) presented on page 31 were achieved with great success giving the true, comprehensive view of the progress in this area of laser technology in the last years.

The scientific value of PhD is, if only, the presentation of main results on the best scientific conferences all over the world, as well as the publishing in a form of review paper in Progress in Quantum Electronics, one of the highest ranked (impact factor > 7) journals in this area of applied physics. For me personally, the greatest impression and impact has the demonstration

for the first time of passive Q-switching & mode locking regime in Er:Y_2O_3 ceramic and Er:YLF crystalline lasers at 3-μm wavelength by means of SESAM modulator. Moreover, from the applications point of view, the design and technological development of Er- microchips is remarkable.

From the viewpoint of laser physics some details could be more deeply examined and explained. Author claims that as a rule the laser resonator was in all experiments (excluding microchips) at the stability edge (half-concentric or hemispherical). In my opinion it was near half concentric (see e.g. case of Er:YAG laser) which shifts forward and backward to stability edge due to thermal and gain guiding effects. The examined gain media have from that point of view the different and opposite properties as fluorides with strong negative thermal dispersion contrary to garnets. May be that self-compensating thermal-lensing effect was a reason of a true cw operation in room temperatures of Er:YLF laser up to 3 W.

I understand reasons of applied in all experiments uncoated samples, but I am not convinced in explanation that uncoated (even nearly perfectly plane parallel) gain media facets does not introduce the additional passive losses. The occurring here, hypothetic etalon effects should be manifested in mode locking regime. Thus, I suppose that with optimized low-loss AR coatings the results can be improved in the future.

Moreover, as drawbacks of thesis I have to mention the minor English grammar and spelling mistakes which I found in the text.

In summary, I conclude that the results presented in the thesis represent a very high scientific level of the Author's research work and skills. The thesis fulfills the requirements for Ph.D. degree in applied and engineering sciences in accordance with Polish Law on Science and Higher Education 2.0 and I recommend it for presentation and defense.