

ASSESSMENT OF THE DISSERTATION

Author:	Ing. Tomáš Halenkovič
Thesis:	Chalcogenide thin films
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Faculty:	Faculty of Chemical Technology
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The thesis of Ing. Tomáš Halenkovič is focused on study of amorphous thin films of ternary Ge-Sb-Se and Ga-Sb-Se systems fabricated by co-sputtering technique for their potential applications in the field of non-linear optics. The surface morphology, linear and non-linear optical properties and structure of prepared films depending on the composition are discussed. The dissertation consists of three main chapters.

The first one is devoted both to theoretical introduction and the review of the studied problematics described in the dissertation. This part gives comprehensive theoretical summary with number of relevant references and serve as a strong basis for consequent chapters of the thesis.

2nd chapter is aimed on the description of experimental procedures. The synthesis of selenide glasses by melt-quenching technique, fabrication of thin films and characterization of chalcogenide glasses and thin films. A lot of relevant analytical techniques focused both on surface and bulk analysis is introduced and described. Selected analytical techniques are supplemented with relevant graphics.

Third chapter summarizes the results which are discussed. This part of the dissertation is devoted to the choice of the particular system, composition and optical properties and quality of co-sputtered and sputtered films. Subsequently the nonlinear optical properties of Ge-Sb-Se thin films, their local structure determined by Raman scattering spectroscopy and photosensitivity of sputtered and co-sputtered thin films is described.

The thesis is written in a clear and understandable way, with a logical structure. Minimal spelling mistakes can be found in the work, specific chapters and subchapters have a reasonable length, the discussion of the results is appropriate.

The documented publication activity of the student is sufficient. The most interesting results were published in journals and conference proceedings. According to the Web of Science (dated January 10, 2019), the dissertant is co-author of 5 impacted papers, which were cited 20 times.

The dissertant showed the abilities to:

- ✓ devote to the current research topic,
- ✓ prepare and analyze a large number of samples,
- ✓ include and ensure a wide range of analytical methods,
- ✓ publish his results into impacted international journals, which is "more and more difficult" and the acceptance of papers in the journals testifies to the originality of the obtained results.

I have some comments/questions regarding the dissertation:

- ✓ sometimes the non-SI units are used, e.g. chapter 2.1 – mbar, etc....,
- ✓ Figs. 2-13, 2-17 – should be $1 \times 1 \mu\text{m}^2$,
- ✓ the title of the dissertation is too general, it should be more specific

Questions:

- ✓ on the basis of comprehensive research in this field, do you have any estimation regarding aging or stability of these layers under high temperature/humidity? This could be crucial for some practical applications,

- ✓ the author stated that the absence of Ge in EDS analysis can be explained by the fact that the deposition rate at 5 W applied on the cathode with GeSe₂ is only ~ 0.6 nm.min. For deposition time 120 min is still would be approx. 72 nm in sum. Is it not possible, that the EDS software just did not assign the peak for Ge element, which would be still present as detectable peak? What is the EDS detection limit of the three studied elements (Ge, Sb, Se)?
- ✓ the author stated (page 90) that with an increased Ar pressure the optical band gap decreased by approximately ~0.1 eV for layer deposited from 2S1G-Se4-Te10 target, and also devoted a significant amount of time to analyze the surface morphology and roughness. Is there any correlation between the optical properties of layers with a different surface roughness or structure (e.g. grain morphology)?
- ✓ the author stated and discussed the effects of photo-bleaching and photo-darkening. Is there any „norm“ for such effects and changes of ΔE_g and Δn as introduced in Table 5, or any information/standard for the maximum change of these values with an increasing irradiation time which would allow to determine whether the layer is „sufficient for use“ or not?

In conclusion I can say that the topic of the thesis is very interesting, with high impact in this field of research, the thesis is well organized and written without any significant errors at an excellent level. The student showed a good orientation in this field of research.

The submitted thesis demonstrates the scientific abilities of the dissertant, meets the criteria for the dissertation, and *I recommend the dissertation for the defense*, and after the defense of the dissertation *I recommend awarding the PhD. degree*.



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V. Švorčík

Prague, 14.1.2019