Referee report of Vojtěch Vozda doctoral thesis

Interaction of short-wavelength laser pulses with matter on various time scales

The thesis deals with effects of XUV/soft x-ray laser irradiation of hard matter samples. The interaction is quite complicated with several subsequent processes, each with its specific time scale. The full description ranges from femtosecond processes of photon absorption by electrons, towards microsecond processes of heat transfer. The intermediate time scale includes desorption and ablation among others. The topic is of nowadays interest with increasing number of free-electron laser facilities in last couple of years.

The thesis are divided into 8 chapters, where chapter 3 is basic theoretical part describing various laser-matter interaction processes sorted according the typical time scale. The experimental results are presented in chapters 6 (beam characterization) and 7 (Experiments). Chapter 7 describes results of three different experiments with aluminium, graphene on silicone carbide and cadmium telluride as target materials.

I have several questions to the author

- What is difference between ablation and desorption? The section 3.2.2 is not very clear how to distinguish these processes. The author mentions paper by J. Chalupský modified the original Haglund's criteria, but I do not understand how they were modified. Citation: "they found that desorption is about an order of magnitude more efficient in case of PMMA exposed to more energetic photons." With respect to which case the desorption is more efficient?
- Another related question: the experiments describe in section 6.3 are divided into desorption imprints and ablation imprints. It is not clear how the experiment was arranged to distinguish those processes. Please explain.
- The data presented in figure 7.5 contain three well separated groups. The last one seems to be composed of two contributions. How was numerically split this group into two subgroups centered at 2.4 μJ and 3 μJ? What is the uncertainty of absorption coefficient value at energy of 2.4 μJ? The high value of absorption coefficient at this energy is suspicious.
- Another question is related to model of absorption in aluminium (section 7.1). The absorption coefficient is plotted as function of electron temperature (defined in Appendix A.4) and electron density n_e. How was electron density determined or which value was used?

The thesis also includes couple of minor typos and inconsistencies. I want to mention few

imperfections:

- "prove" should be replaced by "proof" in figure 3.6 caption.
- The first paragraph on page 30 states the first valuable results obtained using x-ray diffraction was structure of DNA. That is in my opinion great understatement omitting whole field of anorganic crystallography since 1912. Also the x-ray diffraction on DNA experiment was not performed by Watson and Crick but by Rosalind Franklin and Raymond Gosling. Watson and Crick performed the successful interpretation of the experimental data.

V. Vozda reached the main goal, which was to describe response of couple of materials to high energy pulses of soft x-ray of hard UV light. Namely the absorption in aluminium was determined, also thresholds for graphene detachment and destruction. In the last part structural changes of CdTe were studied. As an important part of the experiment evaluation was contribution to the beam profile characteriazation.

According to the Charles University regulations I can say V. Vozda has shown his scientific creativeness and the doctoral thesis meets the required criteria.

Brno, 7. 9. 2020 Mgr. Ondřej Caha, Ph.D.