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Annex No. 10 to the MU Directive on Habilitation Procedures and Professor Appointment Procedures

# HABILITATION THESIS REVIEWER'S REPORT

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| **Masaryk University** | |
| **Applicant** | Mgr. Markéta Holá, Ph.D. |
| **Habilitation thesis** | Laser-matter interaction as a key process for sampling by laser ablation |
| **Reviewer** | Doc. Ing. Tomáš Černohorský, CSc. |
| **Reviewer's home unit, institution** | University of Pardubice, Faculty of Chemical Technology |

The habilitation thesis is a 51-page commentary on a set of 12 published and peer-reviewed scientific papers. All the papers in the set are devoted to laser ablation in conjunction with inductively coupled plasma ionization mass spectrometry (LA-ICP-MS). Some of the papers in the set are directly focused on the problem of aerosol formation and characterization of aerosols generated in the LA-ICP-MS process, while other papers are primarily application-oriented, but also these papers contain valuable information on the problem of matrix and signal effects in LA-ICP-MS. The commentary on all papers focuses only on the issue of the interaction of the laser beam with the surface of solid samples, and its consequences for the formation of an aerosol suitable for dosing into ICP-MS. The work is focused on the keys which are opening the understanding of processes of LA-ICP-MS and which were in the fact the reason why LA-ICP-MS changed during past 20 years from relatively exotic premature method used mainly by geologist to widespread and fully matured method which has impact across wide range of applications from geosciences, archeometry, material sciences, life science (fast high resolved elemental imaging, distribution of nanoparticles in tissues, single cell interactions and etc.) through many fully industrial applications.

The first part of the thesis focuses on the issues of Laser Ablation itself, asks in which situations Laser Ablation can be ideal sampling technique, discusses the effect of fractionation and in particular the techniques which are used for characterization of quality of laser beam interaction with the sample. This section is the most fundamental. It deals with methods for studying of the laser ablation craters, the characterization of the aerosol formed and processing of the time-resolved ICP-MS signal. Especially the complexity of techniques used for aerosols characterization is unique and has also provided unique data important for understanding some of the influences affecting the laser ablation process. All above mentioned techniques were used as fundamental tools for second part of thesis, which is focused on the study of parameters affecting the laser ablation process.

In the second part of thesis, the effects of the laser wavelength, laser pulse duration, laser fluence, spot size and mode of ablation, matrix of sample and physical properties of sample and finally surface of sample (quality of surface, influence of surface modification by nanoparticles) are discussed in detail. Many high-quality experimental data were used for

discussion of all above mentioned parameters, and it can be stated that all of these works have had a significant impact on the development of LA-ICP-MS techniques. Especially the works devoted to fundamental studies have had and, in my opinion, especially now have a major impact on the understanding of the fundamental processes affecting LA-ICP-MS processes. The papers aimed at increasing the efficiency of the ablation process by modifying the surface with nanoparticles are pioneering work and may yield many more very interesting findings and applications in the future.

All above mentioned chapters are deeply discussed in detail but also in a very clear and compact format are demonstrating high skills of author in the fundamentals of LA-ICP-MS.

The author's pedagogical activities are indisputable; she has long been involved in supervising or consulting master's and doctoral theses; these are also successfully intertwined with her scientific activities, as can be seen from the comments to individual theses and the references to the diploma and doctoral theses.

**Reviewer's questions for the habilitation thesis defence**

1) Have you tried looking at nanoparticles other than just Au and Ag nanoparticles? I understand that these particles have the potential to induce a plasmonic effect. Carbon nanoparticles, for example, should in turn have the potential to mitigate the effect of varying photon absorption depending on the composition and quality of the sample surface.

2) Nanoparticles are also likely to increase the aerosol transport efficiency, have you seen selective increases in transport efficiency for some volatile elements?
   We have observed this effect when using carbon nanoparticles in ETV-ICP-MS. Interestingly, in our case we also achieved an increase in efficiency of two to three orders of magnitude, but here it was mainly an effect on aerosol transport efficiency.

**Conclusion**

The habilitation thesis entitled “Laser-matter interaction as a key process for sampling by laser ablation” by Markéta Holá **fulfils** requirements expected of a habilitation thesis in the field of Analytical Chemistry.

Date: 31.8.2024 Signature: