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

HABILITATION THESIS REVIEWER'S REPORT

Masaryk University	
Applicant	Mgr. Jan Čech, Ph.D.
Habilitation thesis	Development of Non-thermal Plasma Sources for Fast Plasma Treatment of Materials: Diagnostics and Applications
Reviewer	Prof. RNDr. Milan Tichý, DrSc.
Reviewer's home unit, institution	Univerzita Karlova, MFF

The plasma technologies that operate at atmospheric pressure gain increasing interest in science as well as in practical industrial applications. The advantage of treating the material surfaces without the need of expensive vacuum equipment opens a new field in material technology. The applicant's habilitation thesis contributes to the physics of two types of atmospheric pressure discharges: (i) the Diffuse Coplanar Surface Barrier Discharge (DCSBD) and (ii) the CaviPlasma technology.

The DCSBD reduces the disadvantage of original DBD by increasing its homogeneity. In DCSBD plasma is generated in thin layer above the surface of dielectric and plasma microchannels are oriented parallel to dielectric surface. The plasma microchannels of DCSBD move rapidly along the surface thus increasing the homogeneity and suppressing the pin-hole effects.

The CaviPlasma technology, originating from Brno University of Technology, Masaryk University (MUNI) and the Institute of Botany of the Czech Academy of Sciences (IBOT) is becoming a technology with global significance. This technology combines the formation of a cavitation cloud associated with efficient liquid mixing and an electrical discharge generated in a reduced pressure environment in cavitation bubbles. In addition to UV radiation, the discharge produces a highly reactive oxidizing environment in the liquid based on peroxide chemistry (i.e. peroxides and peroxo compounds).

The presented habilitation thesis is therefore divided into two principal parts. The first part covers the research on the coplanar dielectric barrier discharges (CDBDs). The second part is focused on the CaviPlasma. The thesis is composed of a collection of previously published works with the applicant being the first author or a co-author, introduced by commentary. Such composition I find useful since it presents directly the main results while, simultaneously, enables the reader to approach the original papers with a more detailed analysis.

Both studied discharges are AC driven which prevents the use of probe measurements common in low-pressure plasma diagnostics. Therefore, the study of discharge development and related phenomena requires non-invasive diagnostic techniques enabling temporal resolution on the microsecond-timescale or better. These requirements were met in applicant's work by adopting optical diagnostics techniques, such as discharge pattern imaging and optical emission spectroscopy, supplemented with electrical measurements. The author mastered the application of ICCD camera for the space and phase-resolved imaging and the optical emission spectroscopy. Further, the author developed processing

codes for datasets import and subsequent analysis, such as image registration or electric measurements analysis. The author was also actively involved in the design of the plasma sources. However, the development of new diagnostic techniques was not the only author's contribution; he was also involved in broadening the application potential of DCSBD and CaviPlasma discharges.

The introductory chapters of the thesis are written in a clear and pedagogical manner. I am therefore pleased to state that the applicant has demonstrated both the ability to conduct independent scientific work and pedagogical skills in his work.

The habilitation thesis is well-composed; I did not find any typos in the introductory/commentary chapters. The cited literature is mostly very new, the newest one is from 2025, and the oldest cited publication is from 1987.

The focus - the main contribution - of the habilitation is undoubtedly in the second part dedicated to CaviPlasma technology. The candidate is a co-author of a world-wide acknowledged patent. Most of the attached publications are in high-quality foreign scientific journals and/ors in collaboration with foreign authors. The attached publications also have a respectable citation response. This documents the high scientific level of the publications co-authored by Mgr. Jan Čech, Ph.D., which are presented in his habilitation thesis. I then conclude that in terms of professional scientific erudition, the candidate complies with the requirements for the title docent (associated professor).

What needs to be commented on is the fact that the list of publications of the habilitation candidate includes only publications with co-authors. The candidate, however, assesses his contribution to individual publications contained in the thesis in terms of content and quality on pages vi-ix of his thesis. In addition, the author estimates his qualitative contribution to the annotated papers on pages ix and x.

Reviewer's questions for the habilitation thesis defence

All the papers annotated in the thesis have undergone decent peer review procedure that documents their quality. However, I would be obliged if the applicant answered the following questions.

1) There exist different methods of water decontamination. E.g. Dr. Hensel from Komensky University in Bratislava studied a method based on the generation of a foam discharge. The foam discharge has proven to be a potentially suitable method for the generation of oxidants and the simultaneous removal of gaseous and liquid pollutants. (See e.g., Pawlat, Hensel, 2004, Czechoslovak Journal of Physics, Vol. 54, Suppl. C, C964).
   Could you compare the efficiency of CaviPlasma technology with that based on the generation of a foam discharge?
2) The spectral components of CaviPlasma discharge cover the wide range of wavelengths from UV to infrared, see e.g., Fig. 20 on page 41. Did you have to use some special glass to be able to measure in such a wide range of wavelengths?
3) CaviPlasma treatment increases the water conductivity up to 10 times the tap water. Simultaneously, you apply an AC high voltage (in fact, I did not find magnitude of the voltage in the thesis text, just the frequency of the high-voltage generator). What safety measures does one apply to prevent injuries?

Conclusion

The submitted habilitation thesis summarizes the basics and new findings in the field of atmospheric pressure AC discharges. It represents a benefit both for the development of the field and for teaching methodology. From the content of the habilitation thesis, I can further

state that the habilitation candidate developed his scientific and research activities and has achieved original results in the field of plasma physics. He published the results of his work in domestic and foreign peer reviewed journals and presented his work at international conferences. He also co-authored a patent describing CaviPlasma technology. In the reviewer's opinion, the number of publications of the author of the habilitation complies with requirements for the habilitation procedure. The record in WoS shows the high citation response of the author's works. The habilitation thesis undoubtedly contributes to the development of the scientific field. For the reasons stated, I recommend the acceptance of Mgr. Jan Čech, Ph.D.'s habilitation thesis for the habilitation procedure for the award of the scientific and pedagogical title of docent (associated professor).

As a reviewer I conclude that the habilitation thesis entitled "Development of Non-thermal Plasma Sources for Fast Plasma Treatment of Materials: Diagnostics and Applications" by Mgr. Jan Čech, Ph.D. **fulfils** requirements expected of a habilitation thesis in the field of plasma physics.

In Prague, November, 5, 2025 Signature: