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Annex No. 11 to the MU Directive on Habilitation Procedures and Professor Appointment Procedures

Habilitation Thesis Reviewer's Report

Masaryk University Faculty	Science
Procedure field	Plasma Physics
Applicant	MGR. Tomáš Hoder, PhD
Applicant's home unit, institution	Department of Physical Electronics
Habilitation thesis	High-resolution Spectroscopy of Transient Micro-Plasma: Discharge Mechanisms and Electric Field Determination
Reviewer	Paolo Francesco Ambrico
Reviewer's home unit, institution	Institute for Science and Technology of Plasmas, National Research Council of Italy

During his career, Dr Tomáš Hoder has carried out considerable research in the field of low-temperature plasma physics. His activity can be framed in the field of advanced diagnostics for plasmas, with particular reference to the category of filamentary discharges or individual streamer. His activity was carried out in collaboration with research groups well known internationally in this sector both as a guest and as an employee of the hosting structures. The leadership assumed in these activities can be inferred from the list of publications reported. Around 57% of publications report Dr Hoder both as first author and corresponding author. He published in journals well-known in the low-temperature plasma community with an excellent impact fact (for the reference field) and a rigorous peer review process.

A bibliometric analysis of the 14 works leads to an average of citations per article of about 23 (as of April 15, 2019), an H index of 12, a total number of citations excluding the auto citations of 292.
The co-authors of the reported works are mainly German and Czech, plus others from main European countries. The 30% of the citations come from Germany, 17% from the Czech Republic, 14% from the USA and China, 8% from France, 6-7% from Holland, Italy and Japan. All countries in which the activities of low-temperature plasmas have a historical presence. Considering these data, we can conclude that the research activity presented is well known and appreciated internationally.
Regarding the scientific aspect of the reported articles, all the papers went through a rigorous peer review process. It is for which it is not my intention to perform further analysis of the published results, but only to analyse the rigorous and methodical aspect of the work done by the candidate. In the present qualification thesis, Dr Hoder links the various moments of his research activity with a single thread: the study of transient micro-plasma discharges with particular reference to the mechanisms and measurement of their electric field. This study was conducted by following three fundamental and complementary phases between them: 1.

Advanced spectroscopic techniques, 2. Determination of the electric field, 3. Electrical diagnostics.

Chapter 1 is undoubtedly the most interesting and advanced aspect of the research activity of Dr Hoder. This chapter reports on the starting of the scientific activity of the candidate. The scientific activities reported seems to be mostly ascribed to Dr Hoder work. About 57% of the discussed papers see Dr Hoder as first author and corresponding author. The use of spectroscopic techniques such as cross-correlation spectroscopy and imaging using ICCD with compatible results between them is very interesting. Nevertheless, the use of methods that require long integration times is somewhat critical in environments such as spatially and temporally unstable streamer discharges. Even if from a temporal point of view the CCS allows in some way an optimal synchronisation of the acquisitions with some shrewdness, from the spatial point of view some criticalities of application of the technique remain due to the nature of the streamer. The last two papers in chapter 1 reports on research not strictly related to the "spectroscopy" of the discharge. Nevertheless, the fast imaging of the discharge through the ICCD in the case of argon discharge can be included in the chapter as an interesting advanced diagnostics of the plasma morphology on a micrometric scale.

Chapter 2 concerns the measurement of the electric field with spectroscopic methods based in the case of discharges containing nitrogen the SPS and FNS emissions and properly calibrating their ratio. This seems the chapter more properly related to dr Hoder current activities and showing the maturity of the candidate in the field. In this chapter, reference is made to 5 articles in all of which Dr Hoder is the first and corresponding author. The technique mainly used is that of cross-correlation except for the first article in which the plasma emission was observed with a fast phototube. Alongside the experimental measures, a good attempt at comparing models with measurements has been realised. There are still issues open such as calibration of the E/N ratio. As stated by Dr Hoder PSST 25, (2016)025017 about the calibration method: "there are still unresolved tasks for this method, future work should clarify ….". I trust that this open point in the current activities will be clarified in the next future by the author.

In Chapter 3, two articles are reported relating to electrical measurements of the discharges and their modelling to get more accurately plasma parameters. This chapter refers to a side activity, no doubt having its importance, but perhaps more distant from the competencies proper to the candidate. This is more or less a technological aspect, but still, the reported contribution is of interest for the complete understanding of the discharge mechanism.

In conclusion, the research activity of Dr Hoder turns out to be coherent and well-articulated in the field of electric discharges for the production of microplasmas. The preponderant aspect of the candidate's activity concerns the characterisation of plasmas using the cross-correlation spectroscopy technique to whose development dr. Hoder has made a noteworthy contribution demonstrated not only by the 14 articles attached to the present thesis but also by the other published papers. The method and the scientific rigour adopted by Dr Hoder in his research activity are exemplary. The scientific production also considered the reference sector is excellent and well cited. Dr Hoder has proved to be a talented researcher able to develop and adapt the diagnostic techniques studied in different environments. I do believe he will become a future leader of the plasma community in the coming future.

Reviewer's questions for the habilitation thesis defence (number of questions up to the reviewer)

- How critical is the spatial variability of the streamer position in the Cross-Correlation Technique?

- How critical is the required long integration in the Cross-Correlation time concerning time stability of the discharge?
- How critical is the use of Interference filters in the evaluation of the E/N ratio?
- Is the Cross-Correlation Technique restricted only to particular discharge configurations?
- What could be in your opinion the next generation of cross-correlation setup?
- Have you resolved all the issues regarding the calibration of the measurements of the E/N?

Conclusion

The habilitation thesis entitled „High-resolution Spectroscopy of Transient Micro-Plasma: Discharge Mechanisms and Electric Field Determination" by Tomáš Hoder ***fulfils*** requirements expected of a habilitation thesis in the field of Plasma Physics.

In Bari, Italy on April 15th, 2019