

Review Report on PhD Thesis

Faculty: **Central European Institute of Technology
Brno University of Technology in Brno**

Academic year: **2025/2026**

Student: **MSc. Megha Mohan**

Doctoral study program: **Advanced Materials and Nanosciences**

Supervisor: **prof. Ing. Jozef Kaiser, Ph.D.**

Reviewer: **prof. RNDr. Pavel Veis, CSc**

PhD thesis title: Lowering the detection limits of Laser-Induced Breakdown Spectroscopy (LIBS) technique via innovative approaches

Topicality of doctoral thesis:

The presented dissertation thesis of MSc. Megha Mohan aims to study a strategy for improving limit of detection and enhancement in Laser Induced Breakdown Spectroscopy (LIBS) by introducing novel triple pulse LIBS. The study also focuses on boundary materials, which is relevant for the analysis of geological samples.

In the introduction, the author has clearly stated the motivation for the current thesis. The author has compared LIBS with other analytical techniques and weighed the pros and cons, like the versatility of LIBS and mentioned the higher limit of the detection in LIBS compared to other techniques.

In the section two, author has outlined the theoretical background briefly followed by literature review for various geometrical configurations for signal enhancement using double pulse LIBS, triple pulse LIBS, enhancement of single pulse LIBS with different kinds of electrical discharges (spar, glow and microwave) is also discussed. The influence of various laser parameters like wavelengths, laser pulse duration, laser re-excitation of selected transitions by tuneable OPO laser (LIF, RELIBS) has been mentioned. She has also mentioned about various other enhancement techniques for improvement of laser induced plasma. The chapter is well written by referring to plenty of published works.

Meeting the goals set:

The author of the thesis has set following goals:

1. To study the influence of material boundaries influence on laser induced plasma characteristics.
2. Optimization of triple pulse LIBS for improvement of LoD

These goals have clearly met with impressive output.

Problem solving and dissertation results:

The author has discussed two different case studies, one for the analysis of the boundary conditions, studied via Cu Sn interface along different angles of observations showing partial mixing of ablated materials in the plume. The second case being the glass materials by triple pulse LIBS techniques. The results are being outlined intelligibly for both the case studies. At the end in Conclusions, the author effectively summarizes the obtained results.

Importance for practice or development of the discipline:

The presented doctoral thesis is important for practice from analytical point of view (improvement of LoD) especially for geological, environmental and space research.

Formal adjustment of the thesis and language level:

The dissertation, which is 98 pages long, is written in English and is clearly structured. The structure of the work is well defined and consists of the following chapters or parts: 1/ Introduction, 2/ Literature review, 3/ Research Gap and Objectives. 4/ Materials and Methods, 5/ Results and Discussions, 6/ Conclusion, Lists of selected published papers, projects, Conferences and Workshops presentations, Appendix A and B with her published papers and References.

Questions and comments:

1/ The idea of pre-ablation pulse influencing on the laser induced plasma is very interesting. Can you comment on experimental conditions of pre-ablation pulse, what was the vertical position of the pre ablation laser focal point over the surface? Fundamentally what is causing the causing mainly the surface modification of the studied surface (UV radiation, heat flow, generated radicals and meta state in pre-ablation laser generated plasma ball over the surface?

2/ Can you comment on the influence of pre ablation laser pulse for extreme interpulse delay (2, 10 us)?

3/ Did you analyse the surface modified by the pre-ablation laser only using different techniques like microscopy, EFM, IR spectroscopy for surface analysis?

4/ Could this pre-ablation laser pulse in ambient air condition in atm. pressure change the chemistry of the surface, for example formation of oxides?

Conclusion:

The results of the author's work were published in 2 articles (mentioned in Appendix A and B in renowned foreign journals with a higher Impact Factor, and she was the first author in all of them. I conclude that the submitted dissertation of MSc. Megha Mohan meets all the requirements for a dissertation in the given field, the student has demonstrated independent creative scientific abilities in the field. In my opinion, the reviewed thesis fulfils all requirements posed on theses aimed for obtaining PhD degree. This thesis is ready to be defended orally, in front of respective committee.

In Bratislava, date 12. November 2025



prof. RNDr. Pavel Veis, CSc