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

Academic year: 2021/2022

Student: Ing. Erik Képes

Doctoral study program: Advanced Materials and Nanosciences

Field of study: Advanced nanotechnologies and microtechnologies

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

Reviewer: RNDr. Martin Ferus, Ph.D.

PhD thesis title: Development of a device and methodology for Laser-Induced Breakdown Spectroscopy (LIBS)

Topicality of doctoral thesis: The thesis is an excellent piece of experimental work, however with rich part involving further processing of large data blocks for physical and chemical analysis, calibration and data evaluation for analytical purposes. LIBS represents a state of the art method. On the other hand, there are still multiple challenges regarding technical problems, necessity of novel instrumental procedures as well as development in data evaluation algorithms. In spite of that, LIBS has been applied for top-level science missions such as ChemCam device on Mars rovers or for laboratory analysis of important archeological and culture heritage. The thesis reflects these problems and provides recent findings leading to significant development in LIBS analysis.

Meeting the goals set: The work has been focused on transfer of analysis models across various systems, various data collection strategies, data processing and transfer of analysis strategies across various LIBS set ups. As indicated in further paragraphs, the work certainly fulfilled these goals.

Problem solving and dissertation results: The thesis introduces significant development of the LIBS methodology and data evaluation. The demonstrates significant contribution of the author towards understanding asymmetric laser induced plasma for laboratory LIBS analysis, spectral acquisition strategies, calibration, handling large amount of data and application of machine learning in this field.

Importance for practice or development of the discipline: The thesis provides very comprehensive theoretical introduction to LIBS technology as well as physics. The style and informational content clearly demonstrate candidate’s deep knowledge of theory and experimental praxis. The thesis shows nice example of data acquisition procedures, developing the strategies and the large data block evaluation
and handling. The reviewer agrees with the conclusion that this thesis has paved path towards application of machine learning models among different LIBS arrangements and experimental conditions. This is especially important regarding variability of LISB set ups used in different laboratories. The reviewer also highlights presentation of multiple top level plasma characterization providing deep information about ablation plasma physical parameters and plasma structure.

**Formal adjustment of the thesis and language level:** The thesis is well and clearly written; however, several typos have been identified by the reviewer. The errors, however, occur in negligible number considering the range of the thesis. The language is well understandable for the reader and English level (but, it should be noted that the reviewer is not native speaker) is very high.

In line with § 47 (4), the study is duly completed for the state doctoral examination and the defense of a dissertation, which will prove the ability and readiness for independent activity in research or development or for independent theoretical and creative artistic activity. The dissertation includes original and published results and the results accepted for publication.

**Questions and comments:**

1. For practical purposes, which laser is according to your opinion more suitable for analytical purposes, LIBS performed using 532 or 1064 nm laser and why?
2. On page 102, you show data collection with the gate width 50 µs. However, according to the reviewer’s experience, characteristic emission is significantly weak already after 10 µs. Can you comment on conditions and instrumentation suitable for observation of atomic emission in such long time window?

**Conclusion:**

In my opinion, the reviewed thesis *fulfill* doesn’t fulfill all requirements posed on theses aimed for obtaining PhD. degree. This thesis is* isn’t* ready to be defended orally, in front of respective committee.

In Prague, January 7, 2022

RNDr. Martin Ferus, Ph.D.