Review Report on PhD Thesis

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

Academic year: **2024/2025**

Student: **Ing. Martin Kovařík**

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

Supervisor: **Prof. Ing. Miroslav Kolíbal, Ph.D.**

Reviewer: **Prof. Umberto Celano, Ph.D.**

PhD thesis title:

Fabrication of functional nanostructures and their analysis by surface-sensitive techniques

Topicality of doctoral thesis:

The thesis focuses on the use of correlative metrology flows using AFM, KPFM and cc-C-AFM. These are combined with other beam-based techniques for the direct probing of AlgaN properties and 2D materials-based devices.

Meeting the goals set:

The thesis is meeting the goal set by expanding the understanding related to the tip-induced analysis of critical materials such as III-Vs compounds.

Problem solving and dissertation results:

The main results are following (1) CAFM characterization of

dislocations in GaN and AlGaN (2) The correlation with electron channeling contrast

imaging is shown. (3) The modification

of the CAFM technique that operates at constant current (cc-CAFM). (5)

application of KPFM is shown in a study on how electron irradiation changes the electrical properties of nanotube devices.

Importance for practice or development of the discipline:

Given the major role of III-Vs in technological application the work is developing multiple areas of development for the material characterization. As such it is considered valuable for the community and provides good development for the discipline.

Formal adjustment of the thesis and language level:

(4) The study is duly completed by a state doctoral examination and the defense of a dissertation, which proves the ability and readiness for independent activity in research or development or for independent theoretical and creative artistic activity. The dissertation must include original and published results or results accepted for publication.)

Original Work is included.

Questions and comments:

What instrument is used in Figure 1.10 ? (it would be nice to have that information added in figures caption)

Any role of the measurement environment in the results shown in Figure 4.2 ? (AlGaN Images of damaged areas after scanning)

To mitigate the problems related to the loss of conductivity, in 4.3 did the author have tested various environments such as High-vacuum vs Air ?

Is the method of cc-CAFM solving any of the tip-induced problems faced with conventional C-AFM on material growth ?

Conclusion:

In summary the thesis meets the requiriments and needs only minor revision to be accepted. The thesis is meeting the goal set by expanding the understanding related to the tip-induced analysis of critical materials such as III-Vs compounds. The author reports on a novel technique that is based on C-AFM with a constant current sensing method, thus useful in situation where limited bias conditions could impact on the sample stability.

In my opinion, the reviewed thesis 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 Phoenix (Arizona), date June 27th 2025

Prof. Umberto Celano, Ph.D.

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