

Reviewer's Report on Doctoral Thesis

Thesis title: Adsorption of Metal Atoms and Growth of Metal Nanostructures on Silicon Surface - STM Study

Candidate: **Michael Alexandridis**

Reviewer: prof. RNDr. Bohuslav Rezek, Ph.D.

The thesis subject focused on oriented 1D nanostructures (atomic metal chains in this case) is highly topical. In spite of being subject of surface science studies for decades, it is actually again more and more relevant not only from science point of view but also for technological advancement of applications in nanoelectronics (and beyond).

The thesis deals with details of processes involved in 1D chain growth, approaching the problem in a novel way by detaching atoms from chains at room temperature (RT) rather than more conventional studies of individual atoms slowed down at very low temperatures (LT). This measurement concept can in fact bring also more relevant information for practical RT applications of such 1D chains.

STM as the main research method was chosen and employed properly. All the presented STM measurements are very nice. They are also successfully matched with structural and kinetic models, which is highly appreciated and beneficial. I find **several results of the thesis in particular valuable**. First, the effect of surface defects on atomic chain formation and deconstruction has been carefully characterized, evaluated and discussed. Different defect interaction with Sn and Al adatoms was clearly evidenced. Second is the study of anisotropic adatom hopping. Another valuable feat are statistical analyses of the observed phenomena based on repeating challenging STM experiments.

From technical point of view, the thesis is very well written, logically organized, readable and well understandable. It describes well the theoretical and state-of-art background including nice explanations of STM theory, Si atomic surfaces, dimers and clusters formation, surface "polymerization" reaction, etc. I appreciate that it also mentions useful practical notes on STM measurements (LDOS issues, drift, double tip, surface preparation, real-time measurements). The images and figures in the thesis are of high publication quality.

Minor technical issues are that the Results section should have been named rather as "Results and discussion" as it contains also essential discussion of the data and standalone discussion section is missing. Conclusion could have mentioned also broader implications of

the results and possible further directions. Some Figures in introductory parts should be more clearly indicated as reprinted or own (2.2, 3.2, 3.3).

I have **several questions to be discussed** during the defense of the thesis:

- 1) How safe is the assumption that “desorption is negligible” and “not allowed in the model” in the room temperature experiments?
- 2) How the Si surface defects hidden below the metal chain can affect the observed activation energies, in particular in the case of Sn?
- 3) What other microscopic and spectroscopic methods could have been used to corroborate the STM and simulation data? Were some tried and with what result?
- 4) What all has been done by the candidate personally and what was done by colleagues and collaborators. Such information is missing in the thesis.
- 5) Only < 10 / 123 references are from the last ten years. What would be a more up-to-date literature in the field and its relation to the presented results?
- 6) There is only one journal paper from 2017 with only 3 citations so far. Why were all those nice results not turned into more impact journal publications?

Assuming that the above questions are successfully addressed, the thesis itself has been very well prepared and it suggests that the candidate has a capability to perform with a high degree of independence a high quality scientific work and obtain new knowledge that I believe is applicable both in further scientific research and state-of-art applications.

I thus fully recommend the presented thesis for defense of the Ph.D. degree.

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