Appraisal of bachelor thesis – opponent

Opponent’s name: Mark H Rummeli

Supervisor of the thesis: Daniela Plachá

Opponent:

Title: Methods of treatment and functionalization of carbon nanotubes

Student: Ondřej Dutko

1. Is the thesis consistent with its assignment?
   In this study the student was to tackle and discuss a variety of methods to treat carbon nanotubes (CNT), such as purification, as well as to explore the treatments that functionalize the CNT that would lead to a modification in certain properties of the CNT. The presented thesis does indeed provide a series of successful experiments to treat (e.g. anneal the nanotubes) and to functionalize the nanotubes thereby adding new functional groups to their surface and thus alter their physico-chemical properties. The thesis is in agreement with its assignment.

2. Basic Evaluation of the thesis:
   Overall the thesis is well structured. Initially carbon nanotubes are introduced after which different treatments and functionalization approaches for CNT are presented. Overall sections 1 and 2 are clear and useful sections. I would have liked to see a little more emphasis on applications, in particular applications that benefit from functionalized CNT. Section 3 then enters in to the practical aspects of the thesis. The choice in treatments to be explored is clearly given and then the various treatments are applied and then compared through a variety of characterization routes. The work, at times, could have benefited with a little more clarity and critical thinking (see point 3 & 5). Finally conclusions are drawn which again could have provided a little more depth. That said, overall this is a good thesis.

3. Comments and critical notes
   The author has conducted a wide variety of experiments in terms exploring various functionalization approaches and conducting numerous characterizations for each produced samples as well as the starting samples. I would have like to have seen a little more understanding of the characterization routes in terms of the materials studied along with a little more comprehension of the limitations and strengths for each technique. For example the author describes changes for the different samples when investigated by FTIR as "intensity lowered in all bands." This is not quite correct since the author is not working with total intensity measurements (very difficult to achieve) but rather works with relative measurements.
Another example is the discussion on the Raman modes where for example the author states the important of the relative D and G modes for assessing the CNTs structural integrity without really explaining why this is so (e.g. the D mode sensitivity to defects). In the same vein why are RBM not anticipated in the Raman spectra? In addition, clarity as to the purpose of the functionalization was sometimes lacking. For example the author highlights the potential of functionalization to enable dispersed CNT. Why this is so important was not clearly presented and should have been. On the plus side, the author was able to work with numerous characterization techniques and for the most part able to bring the different data together.

4. Evaluation of the selection and utilization of literatures:
Here the author has really made excellent choices in determining appropriate literature for the thesis both in terms of background/review literature and also in terms of experimental literature. The author made a fair attempt to connect their own data with that from others in the literature. This could have been covered in a little more depth, however I acknowledge this skill is something that typically grows during a young scientist’s career. I am sure this will improve over time for the author.

5. Evaluation of the formal aspects of the thesis:
Overall this is a very good thesis. While improvements could definitely be made, the author does provide a good background to the reader and sets up the reader well for the experiments. Clearly a lot of experiments and characterizations have been conducted. A little more critical thinking on the experimental results/conclusions would have been nice. That said, the overall structure of the thesis and the experimental approach by the candidate is good.

6. Describe whether the thesis has findings and how they could be used:
The thesis does indeed have findings, namely the starting CNT are already somewhat functionalized and that this can be reduced through an annealing process. In addition the author demonstrated they are able to successfully functionalize the CNT using a variety of wet chemical treatments. These are not really new findings as this is a heavily studied theme internationally. However, I would not expect major new findings for a thesis for this academic level and so this does not worry me at all. The core aim, in my opinion, is that the student is able to research a subject, and then learn the relevant experimental techniques, is then able to successfully reproduce the experiments and finally evaluate the data. The author of this thesis has achieved these objectives very well, albeit some improvement could be achieved as I have discussed in other sections above. Overall, this is a very good thesis.

Date: Signature: