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Opponent's review of doctoral thesis
„Charge carrier transport in conjugated polymers with controlled morphology“
submitted by Udit Acharya

Udit Acharya's thesis deals with a highly current topic, developing new materials for organic electronic devices that could offer novel functionalities. The submitted work has a logical structure and appropriate division. The thesis is in perfect English, containing only a few mistakes and typos (e.g., inconsistent use of italic font and erroneous reference to Attachments 2 and 3). Its content shows that the author has managed to penetrate the given issue to a high degree.

I strongly appreciate that the dissertation summarizes seven already published peer-reviewed journal articles. The impact factors and Q1 quartiles of these journals also affirm the excellent quality of the presented thesis.

The introduction is adequate and links the content of the dissertation logically together. Experimental methods for characterizing the selected materials were appropriately chosen and correctly applied, and the overall interpretation of the results achieved is convincing. The author proved high standards at both theoretical and methodological levels. Conclusions are formulated correctly.

The topic of influencing the electrical properties of polymers by optimizing the morphology is current and essential for progress in the preparation of new electronic devices. Using organic dyes or oligomers with shorter conjugated sequences linked together in metallo-supramolecular coordination polymers in the reaction mixture during polymerization is an intriguing approach to this topic. I exactly consider the addition of organic dyes (anionic or cationic) to the polymerization of pyrrole leading to a record DC conductivity of the PPy nanostructure due to changes in morphology from globular to nanofibrillar and nanotubulart the most valuable result of the work.

Likewise, observing an increase in conductivity of PPy/MoS2 composites compared to that of neat components due to PPy chain ordering favourable for the transport of charge carriers is very interesting. Identifying the main charge transport mechanism as the variable-range hopping is important for polymer nanocomposite research and applications.

An interesting insight was also obtained by the broadband impedance spectroscopy of synthesized PPDA/MMT composites. The charge transport mechanism in this composite has been shown to be

temperature dependent, with correlated polaron barrier hopping occurring at temperatures below 273 K in the PPDA and ion transport in the higher temperature range in MMT.

I have the following questions and comments for the doctoral student about the submitted work:

- What practical applications of the studied materials can be expected in the coming years?
- The literature often mentions that the conclusions and outcomes obtained on organic/inorganic composites are often ambiguous and system specific. To what extent does the applicant agree with this opinion?

In conclusion, Udit Acharya has proved with the submitted dissertation that he has good theoretical knowledge and the ability to conduct challenging experiments. His ability to systematically work on a given scientific topic and to bring his views to it points to his qualifications for further independent work in research. The submitted work brings innovative knowledge related to the research topic. The presented results significantly impact the organic semiconductors community, as it is confirmed by receiving more than 110 citations at the moment of this opponent's review preparation on the scientific articles included in the submitted thesis. Udit Acharya has demonstrated the ability to do analytical and synthetic creative work in the field of research. Therefore, I recommend the dissertation thesis for defence. After a successful defence, I recommend conferring PhD title on Udit Acharya.

Bratislava, June 8, 2023

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