

Hannover, 31.01.22

Report on the PhD thesis titled

„Effect of heterovalent doping on structure and photostimulated processes in CsPbBr₃ halide perovskite“

submitted by Mr. Ali Ibrahim Mohammed Sharafeldin in partial fulfilment of the degree of Candidate of Physical-Mathematical Sciences (Ph.D.)

Mr. Ali Ibrahim Mohammed Sharafeldin has presented a very well written version of his thesis that (in 136 pages!) clearly shows how much work has been performed. However, it is not only the quantity of the work included in this thesis that is impressive but it is also its extremely good quality that deserves to be highlighted! Mr. Sharafeldin has prepared (employing the method of precipitation chemistry) and carefully characterized a number of Silver- and Bismuth-doped CsPbBr₃ perovskites (*i.e.*, replacing some of the Pb in CsPbBr₃ by Ag or Bi, respectively). The basic characterization of these materials was realized by performing X-ray diffraction studies, X-ray photoelectron spectroscopy, scanning electron microscopy, and energy-dispersive X-ray analysis of each sample (*cf.* Chapter 3). The main focus of this thesis work was to investigate the optical properties of all newly prepared materials. While Chapter 4 presents and discusses in detail the optical properties of all samples including the kinetics of their photocoloration, Chapter 5 presents the results of a very detailed photoluminescence study. It is interesting to note that while Ag doping does not affect the fundamental light absorption of CsPbBr₃ and does thus not change its optical bandgap, Bi-doping significantly extends the spectral absorption region towards the extrinsic region. Moreover, while doping with Ag significantly facilitates the photostimulated formation of new defect states, doping with Bi results in a strong resistance to any photostimulated defect formation.

Based upon these results detailed mechanisms to explain these optical properties as well as the role of the different doping ions and the potential of these perovskites to act as suitable materials for photovoltaic applications have been suggested which can be regarded as really important contributions to this research field. Both, the introduction and the literature review into his topic (together more than 40 pages incl. 125 references) as well as the detailed discussion of his results evince that Mr. Sharafeldin is already a real expert in this field of research and he has thus shown his capability and competence to work as a (very good) scientist.

Even though the thesis work has just been completed, Mr. Sharafeldin has already published parts of his work in peer-reviewed scientific journals (one papers in 2019 and three papers in 2021) and has presented his work at several national and international conferences.

In summary, Mr. Ali Ibrahim Mohammed Sharafeldin is recommended to

- a) continue with the further steps required to obtain the degree of Candidate of Physical-Mathematical Sciences at Saint-Petersburg State University (Russian Federation), *i.e.*, with the defence of his thesis and
- b) be eventually awarded with the title of Doctor of Philosophy that he truly deserves!

I recommend that the thesis be accepted for the degree of Candidate of Physical-Mathematical Sciences!



Detlef Bahnemann