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Report on the doctoral thesis submitted by Ms. Amelia Klimek

“Sustainable electrochemical energy storage systems working in aqueous medium with high-voltage and long-term cyclability”

The PhD work presented by Ms. Amelia Klimek deals about different strategies for the development of electrochemical capacitors with high capacitive performance and long-lifespan using aqueous electrolytes, being this a very important issue from both a fundamental and applied points of view.

The work contains eleven chapters related to introduction, results and general conclusions. The first three chapters consist of a review of the literature about electrochemical capacitors, electrolytes and electrodes used in these devices, which is very helpful to put the PhD work in context, taking into account that the results deal about improvement of aqueous electrolyte, development of gel electrolyte and synthesis of carbon materials as electrodes.

Chapters 6 to 10 present the results obtained in this work. These chapters correspond to four papers already published in high impact journals and one of them is under review. The high quality of the journals in which the manuscripts have been accepted and the detailed peer review process that has been applied is a further demonstration of the excellence of the PhD Thesis.

Chapter 6 describes an original approach to improve the stability of aqueous based electrochemical capacitors through the addition of urea which is hydrogen bond donor that modifies the reactivity of water molecules. The results are very interesting in terms of new scientific knowledge achieved as well as from a technological perspective. Chapter 7 studies the effect of the addition of iodide/iodine redox pair and an appropriate buffer to fix the pH. The results demonstrate the possibility of increasing the voltage of the capacitor by minimizing the undesired secondary reactions while preserving the desired reversible redox iodine/iodide pair. Chapter 8 deals with a very interesting topic from a circularity and sustainability points of view, since it focuses on the use of lignin to obtain both gel electrolyte and a porous carbon. The study demonstrates the significant reduction in environmental impact of the electrochemical capacitor compared to the conventional materials employed in the devices. Chapter 9 contains a fundamental study about the relationship between structure/porosity/surface chemistry of porous carbons and performance of the capacitors in aqueous electrolyte.

The results obtained deepen into the fundamentals of electrochemistry of carbon materials, this study is very useful to increase the knowledge in Carbon Science.

Consequently, the doctoral dissertation demonstrates general theoretical knowledge of a person applying for a doctoral degree in a chemical science discipline. Moreover, the content of the PhD work, which contains 4 papers already published, shows that the applicant applying for a doctoral degree, has more than enough skills to conduct the scientific activity. In addition, as already discussed, the content of the work is a very important combination of original fundamental and applied research that contribute to the solution of scientific problems in the field of electrochemical capacitors, as well as from an application point of view, since one of the main objectives is to increase the lifetime of the capacitors through sustainable and low environmental impact approaches.

The PhD work also included the most relevant conclusions, as well as a summary in three languages, in accordance with its international character, and the co-tutelle nature of Thesis.

In summary, this is an excellent piece of work that meets the requirements for the award of the PhD degree.

For that reason, I would like to recommend awarding the dissertation and conferring the Ph.D. degree to Amelia Klimek with distinction (honors).

I am favourable for the Ph.D. defence of Ms. Amelia Klimek in the view of obtaining the PhD degree from the University of Poznan, Poland and University of Haute-Alsace, Mulhouse, France.

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