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Cover Profile

Graphitic-Based Solid-State Supercapacitors: Enabling Redox Reaction by In Situ Electrochemical Treatment

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Invited for this month's cover picture is the group of Integrated Nano Systems Lab (INSys Lab), part of the Centre for Clean Energy Technology, University of Technology Sydney. The cover picture illustrates an efficient in-situ pathway to generate and attach oxygen functional groups to graphitic electrodes for supercapacitors by inducing hydrolysis of water molecules within the gel electrolyte. Read the full text of the article at <xref href="http://dx.doi.org/10.1002/batt. 201900204/full">10.1002/batt. 201900204</xref>

*"**Enabling redox reaction without additives**: A simple path is developed to enable stable redox reactions in PVA-H_2SO_4 gel electrolytes without the addition of external redox agents. This method relies on generating oxygen functional groups by inducing hydrolysis of water molecules within the gel electrolyte, which promotes functionalization of the graphitic*

electrodes. Also, we show that the oxygen functionalization simultaneously improves the double-layer contribution to the overall capacitance thanks to improved electrolyte intercalation of the graphitic electrodes." Learn more about the story behind the research featured on the front cover in this issue's Cover Profile. Read the corresponding article on <xref href="http://dx.doi.org/10.1002/batt.201900204/full ">10.1002/batt.201900204</xref>

How would you describe to the layperson the most significant result of this study?

Answer. Quasi-solid-state supercapacitors are not yet quite as performant as their counterparts based on aqueous electrolytes. This study demonstrates a simple pathway to significantly improve the performance of quasi-solid-state supercapacitors using a gel-based electrolyte - and graphitic electrodes, without adding any other agent to the system. The improvements stem from an in-situ functionalization of the electrodes, triggered by the hydrolysis of water molecules within the gel electrolyte to stably attach oxygen functional groups to the electrodes' surfaces. This approach paves the way to develop further miniaturized on-chip energy storage systems, which are compatible with silicon electronics and can support the power demand to operate integrated smart systems.

What was the inspiration for this cover design?

Answer. This cover image emphasizes the in-situ functionalization of the graphitic electrodes as triggered by the hydrolysis of water within the gel electrolyte. It illustrates that the generated oxygen functional groups are attracted to the graphitic electrodes leading to the functionalization of the graphitic electrodes.

Did serendipity play a part in this work?

Answer. Our group have been systematically exploring various ways to improve the performance of supercapacitors fabricated on silicon substrates. However, unpredicted phenomena occurred while exploring the cells widely beyond the standard operating potential window of the PVA-H_2SO_4 gel-based electrolyte, out of curiosity. We have suddenly noticed a significant improvement in the capacitance performance once coming back to the usual voltage window. These were totally unexpected but very positive results; therefore, we have decided to investigate this further and found that this change was permanent and stable. We

eventually managed to identify the source of this beneficial change, explain the reasons for the modifications, as well as to repeat and control the process. The control of the process would not have been possible without understanding the fundamental reasons for the observed improvement, and in this respect, the high interdisciplinarity of our team with core expertise in chemistry, engineering, and materials has been key.

Is your current research mainly curiosity-driven (fundamental) or rather applied?

Answer. Our research has a focus on applied research which is strongly anchored on the understanding of the fundamentals. Demonstrating a simple process to enhance the performance of solid-state supercapacitors presents significant importance for applications like highly reliable integrated power sources. However, the idea behind this work has originated from pure curiosity by the research team and their persistence in fully exploring something unforeseen and building a complete description of the phenomenon.

What future opportunities do you see (in the light of the results presented in this paper)?

Answer. The procedure reported here has the potential to be employed for enhancing the capacitance performance of any graphitic based supercapacitors. Hydrolysis of water can be further explored as a source for active oxygen functional groups to synthesize functionalized materials, especially, where the water-based electrolyte is present.

Who pays the bill for the research highlighted in the cover?

Answer. The Faculty of Engineering and Information Technology (FEIT), as well as the Centre for Clean Energy Technology at the University of Technology Sydney (UTS), are kindly acknowledged for supporting this work with access to state-of-the-art facilities. The authors gratefully acknowledge the Air Force Office for Scientific Research through the Asian Office for Aerospace Research and Development (AOARD, grant 18IOA052) for funding this research.

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Scheme^^1 Photo caption

Scheme^^2 Photo caption