Addressing leakage current in graphene supercapacitors using electret-coated separators

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Abstract:
Electrochemical double layer capacitors (EDLC), commonly referred as supercapacitors (SC) are electrochemical charge storage devices operating at high power densities between 10^2-10^5 W kg^{-1} albeit lower energy densities of the range 0.1-10 Wh kg^{-1}. They occupy a unique niche among electronic components as they complement batteries in terms of performance. Although they do not produce energy or store high amounts of energy like batteries, they can release the stored energy in a short interval leading to a high power output and can be cycled up to a million cycles, multiple orders greater than regular batteries [1]. Due to these reasons, they are used in various power applications such as back-up power supplies and for powering electric vehicles and unmanned wind turbines [1, 2].
In this contribution, we discuss the charge storage in SCs, that takes place at the electrochemical double-layer formed at the interface between its electrode and electrolyte. Graphene, due to its high mechanical strength, large surface area, and dielectric nature forms the ideal choice for active material of this electrode [3]. Acetonitrile, whose conductivity enhanced by dissolved ions forms the electrolyte in these experiments. We find that a very large amount of charge storage at the interfaces aspired by the SCs is entropically unfavourable and have a thermodynamic tendency to leak, which appears as the leakage current in the system. One approach to mitigate this leakage may be the application of an opposite polarisation to the direction of charge diffusion. We achieve this through the use of electret-coated separators. An electret is a material that has a permanent, macroscopic electric field at its surface [4]. In this contribution, we discuss the effect of electret coating on the performance of SCs, evaluated through metrics such as leakage currents, capacitance, and equivalent series resistance.

References

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Figures

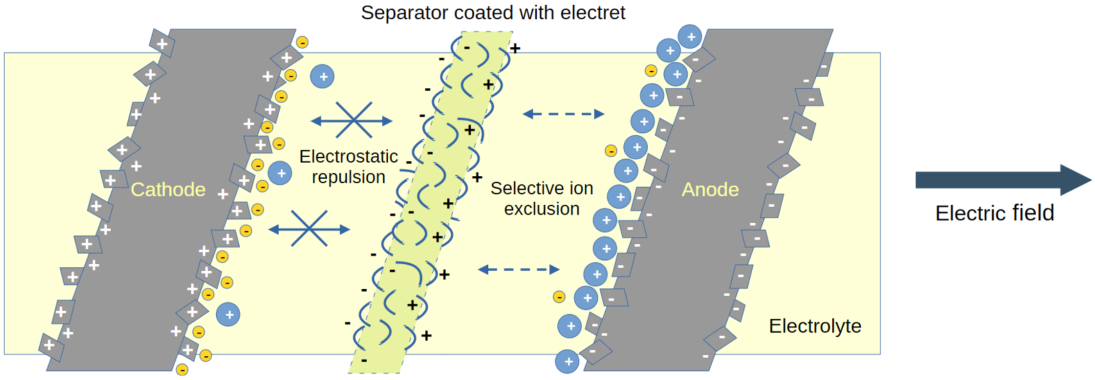

Figure 1: A scheme of the action of electret-coated separator in reducing leakage current.