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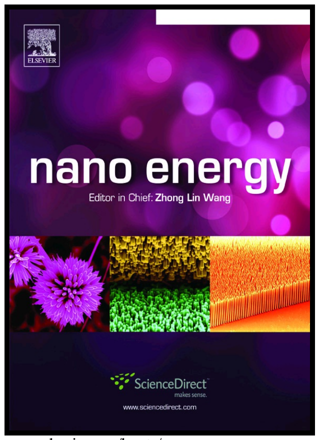

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Suppressing Self-Discharge of Supercapacitors *via* Electrorheological Effect of Liquid Crystals

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Abstract

For electric double layer capacitors (EDLCs, or supercapacitors), self-discharge has been an inevitable issue that causes decay of cell voltage and loss of stored energy, but this problem has long been ignored in the studying of supercapacitors. Due to self-discharge, applications of supercapacitors for long-term energy storage or collecting environmental energy harvested by small power devices have been severely limited. There are three main self-discharge processes for EDLCs, including i) charge diffusion and redistribution, ii) faradaic reactions, and iii) ohmic leakage. In this work, we introduced a nematic liquid crystal 4-n-pentyl-4′-cyanobiphenyl (5CB) as an additive to the electrolyte to suppress the self-discharge of EDLCs. When the EDLCs are charged, the electric field in the double layers near the electrode surface induces alignment of 5CB molecules, causing much enhanced fluid viscosity via the so-called electrorheological (ER) effect. As a result, the diffusion of ions and redox species in the electrolyte can be impeded and the self-discharge rate can be reduced. Here, we have demonstrated that by adding 2% of 5CB in $TEMABF_4$/acetonitrile electrolyte, the decay rate of open circuit potential and leakage current can be reduced by more than 80%. Simulation results confirmed the reduced contribution of both diffusion of ions and faradaic reactions to the overall self-discharge. Furthermore, when 5CB EDLCs were employed for