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EMBEDDED CHIP-SCALE ELECTROCHEMICAL DOUBLE LAYER CAPACITORS WITH PSEUDOCAPACITIVE FUNCTIONALIZATION AND TAILORED IONIC LIQUID-BASED ELECTROLYTES

Abstract

Space exploration demands new, high energy, low mass, and low volume energy storage devices. Supercapacitors outperform battery technology with high power densities and cyclability, features that would be extremely useful for rechargeable energy storage needs, such as on-board mini exploration scouts to be included on larger mission chassis. This research is focused on the development of carbon nanotube-embedded electrochemical double layer (ECDL) supercapacitors that feature a novel pseudocapacitive functionalized architecture, achieved by a combination of graphination and functionalization with a pseudocapacitive material, such as TiO2. There is no existing chip-scale supercapacitor technology that incorporates this type of pseudocapacitive layer with a tailored ionic-liquid electrolyte. Current research has delivered related products by using other types of carbon electrodes (e.g. carbon onions, carbon cloth, carbon aerogels) but so far, these products have consistently fallen short of the requirements for space exploration, such as demonstrated operation in a larger temperature range. In this work, a series of ionic-liquids were tested against the functionalized pseudocapacitive architectures, enabling the determination of the best combination. These results were used to direct the development of new ionic-liquid anode-cathode pairs which were thus developed and examined, yielding a new series of ECDL capacitors with pseudocapacitive functionalization and tailored ionic liquid-based electrolytes. These reduced size and mass capacitors were tested for functionality at room temperature as well as at temperatures between -60 and 125 degrees celsius, extremes beyond the current state-of-the-art capabilities and suitable for many NASA applications.