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3D Interconnected Carbon Nanostructures for Filter Capacitor Applications

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Abstract

Filter capacitors play a critical role in ensuring the quality and reliability of electrical and electronic equipment. Circuit filtering has been dominated by aluminium electrolytic capacitors (AECs), which, unfortunately, are always the largest electronic component due to their low volumetric capacitances.

Therefore, developing new small-sized filter capacitors is highly desirable to meet current and emerging digital circuits and portable electronics demands. The high areal and volumetric capacitance of electric double-layer capacitors should make them ideal miniaturized filter capacitors, but they are hindered by their slow frequency responses. However, the slow response of electric double-layer capacitors could be modulated to meet the needs of circuit filtering applications by manipulating electrode materials and structures to enhance electrical and ionic conductivities.

We report the development of interconnected and structurally integrated carbon tube grid-based electric double-layer capacitors with high areal capacitance and rapid frequency response. The grid with truly-interconnected and structurally integrated vertical and lateral carbon tubes can provide high structural stability, superior electrical conductivity, and effective open porous structure. They exhibit excellent line filtering of 120 Hz voltage signal and volumetric advantages under low-voltage operations for digital circuits, portable electronics, and electrical appliances. The findings provide a sound technological basis for developing electric double-layer capacitors for miniaturizing filter and power devices.