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High aspect ratio and low leakage current carbon nanosheets based high-k nanostructure for energy storage applications

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Abstract :

Carbon nanosheets (CNS) are exploited to fabricate a high aspect ratio strontium titanate (STO) structure with very low leakage current density. CNS are grown by chemical vapor deposition (CVD) on 70nm layer of TiN coated Si wafers. Atomic layer deposition (ALD) is employed as a conformal deposition technique for Sr-rich STO on top of 3D CNS to obtain a conformal STO layer with high area per footprint. The area enhancement resulting from CNS is investigated using electrochemical impedance spectroscopy (EIS) for conformally deposited Al_2O_3 thin films based TIN blanket and CNS, electrodes. It is investigated by comparing the capacitance enhancement resulted from CNS/Al_2O_3 capacitors with that obtained from blanket TiN/ Al_2O_3 capacitors. Our findings show that EIS is very promising for estimating the area increase for different nanostructures. The electrochemical spectroscopy show typical capacitor behavior for CNS based electrochemical capacitors. Moreover, solid-state electrical characterizations for CNS/STO based metal-insulator-metal (MIM) capacitors show very low leakage current density with strong breakdown and excellent area scaling through the potential window [0 V, +10V].