Carbon Nanotube-confined MnO_2/C-MEMS Nanostructures for On-chip Electrochemical Capacitors

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Electrochemical Capacitors (ECs) with substantially higher power densities, faster recharge rate and longer cycle lifetimes are the ideal electrical energy storage technologies for meeting future energy demands. However, energy densities of ECs are generally lower than those of batteries and are insufficient for many applications in which significant energy storage is needed. Here, we are using carbon nanotube (CNT) confined MnO_2 composite as electrode materials of ECs, i.e., combining double layer (e.g., CNTs) and pseudocapacitive (e.g., MnO_2) type into one capacitor. On the other hand, developing miniaturized capacitors compatible with current semiconductor processing is an important direction for ECs, which exhibits especially a big potential on solving national defense and homeland security problems. We integrate the above CNT-confined MnO_2 composites into very small footprint, i.e., on-chip ECs. Cyclic voltammetry shows that the C-MEMS nanostructral materials exhibit typical rectangle shape and have a high specific capacitance. We attribute this improvement to the synergetic enhancement in the pseudocapacitance of MnO_2 inside CNTs. In addition, Electrochemical impedance spectroscopy will be measured to distinguish and analysize the double layer and pseudocapacitive behaviors of CNT-confined MnO_2 composite, which will help us to understand how the active materials store/transport charge and optimize further the fabricating process.