Porous W_2N Fibrous-Nanograins and TiN Nanopyramids Framework for High Energy Density Flexible Asymmetric Supercapacitors

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Abstract: Enhancing the energy density of flexible asymmetric supercapacitors (ASCs) necessitates developing and implementing high-performance anode materials for technological developments in wearable energy storage systems. Tungsten nitride (W_2N) offers enormous potential as an anode material for ASCs, ascribed to its substantial specific capacitance, massive electrical conductivity, and extended negative potential window. In this work, we fabricated a durable coin cell and flexible ASC utilizing W_2N/SSM fibrous-nanograins anode and TiN/SSM nanopyramids cathode deposited over flexible stainless steel mesh (SSM) substrate by the DC magnetron sputtering technique. The W_2N/SSM//TiN/SSM ASC device demonstrates a high areal capacitance of 21.3 $mF.cm^{-2}$ operating across a wide and stable electrochemical voltage window of 1.3 V with outstanding cycling robustness demonstrating 89.09% retention over 8000 charge-discharge cycles. Notably, the ASC achieved a high energy density of 34.33 $mWh.cm^{-3}$ and a high power density of 17.32 $W.cm^{-3}$. The persistent electrochemical performance of ASC is mainly attributed to the dominance of surface-controlled capacitive and pseudocapacitive charge storage kinetics of W_2N/SSM for Na^+ ions comprehensively examined employing 3D Bode and Dunn's techniques. The flexible ASC shows remarkable mechanical stability of 92.36% up to 500 bending cycles. This study establishes W_2N nanograin's potential as a high-energy anode material, revealing the capability to increase the effectiveness of ASC for portable and miniaturized energy storage devices.

References

1) Rajesh Kumar, Bhanu Ranjan, and Davinder Kaur. "Porous W_2N fibrous nanograins and TiN nanopyramid framework for high-energy density flexible asymmetric supercapacitors." *Applied Physics Letters* 126.13 (2025).

GRAPHICAL ABSTRACT