World Academy of Science, Engineering and Technology
International Journal of Chemical and Materials Engineering
Vol:18, No:04, 2024

Smart Energy Storage: $W_{18}O_{49}$ NW/$Ti_3C_2T_x$ Composite-Enabled All Solid State Flexible Electrochromic Supercapacitors

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Abstract : Developing a highly efficient electrochromic energy storage device with sufficient color fluctuation and significant electrochemical performance is highly desirable for practical energy-saving applications. Here, to achieve a highly stable material with a large electrochemical storage capacity, a $W_{18}O_{49}$ NW/$Ti_3C_2T_x$ composite has been fabricated and deposited on a pre-assembled Ag and $W_{18}O_{49}$ NW conductive network by Langmuir-Blodgett technique. The resulting hybrid electrode composed of 15 layers of $W_{18}O_{49}$ NW/$Ti_3C_2T_x$ exhibits an areal capacitance of 125 mF/cm², with a fast and reversible switching response. An optical modulation of 98.2% can be maintained at a current density of 5 $mAcm^{-2}$. Using this electrode, we fabricated a bifunctional symmetric electrochromic supercapacitor device having an energy density of 10.26 μWh/cm² and a power density of 0.605 mW/cm², with high capacity retention and full columbic efficiency over 4000 charge-discharge cycles. Meanwhile, the device displays remarkable electrochromic characteristics, including fast switching time (5 s for coloring and 7 s for bleaching) and a significant coloration efficiency of 116 cm²/C with good optical modulation stability. In addition, the device exhibits remarkable mechanical flexibility and fast switching while being stable over 100 bending cycles, which is promising for real-world applications.

Keywords : MXene, nanowires, supercapacitor, ion diffusion, electrochromic, coloration efficiency
Conference Title : ICC 2024 : International Conference on Chemistry
Conference Location : Chengdu, China
Conference Dates : April 11-12, 2024

Open Science Index, Chemical and Materials Engineering Vol:18, No:04, 2024 publications.waset.org/abstracts/184337.pdf