World Academy of Science, Engineering and Technology
International Journal of Energy and Power Engineering
Vol:19, No:03, 2025

Graphene-Intercalated P4Se3@CNF Hybrid Electrode for Sustainable Energy Storage Solution: Enabling High Energy Density and Ultra-long Cyclic Stability

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Abstract : Non-metal-based compounds have emerged as promising electrodes in recent years to replace scarce and expensive transition-metals for energy storage applications. Herein, a simple electro-spinning technique followed by carbonization is used to create tetraphosphorus triselenide(P4Se3)nano-flakes encapsulated in carbon nanofiber (P4Se3@CNF) to obtain a binder-free, metal-free and flexible hybrid electrode with high electrical conductivity and cyclic stability. A remarkable capacitive performance (5.5-folds@P4Se3) of 810Fg-1/112.5mAhg-1@0.9Ag-1 has been obtained using P4Se3@CNF electrode with an excellent rate capability compared to pristine(P4Se3) which is further supported by theoretical calculations via intercalating graphene within bare P4Se3 flakes inducing partial charge redistribution in hetero-structure. A flexible pouch-type hybrid-supercapacitor followed by coin-cell has been manufactured offering exceptional energy-density without sacrificing power density and ultra-long durability over 35000 and 100000-cycles with capacitance-retention of 99.77% and 100%, respectively. It has been demonstrated that as-fabricated device has practical usefulness towards renewable energy harvesting and storage via integrating commercial solar cell module with supercapattery array that can enlighten the blue LED approximately for 31minutes, rotate the homemade windmill device, power Arduino and glow “INST” against 2minutes of charging. This work demonstrates a facile route towards the development of metal-free electrochemical renewable energy storage/transfer devices offering an inevitable adoption in industrial platforms.

Keywords : metal free, carbon nano-fiber, pouch-type hybrid super-capacitor, nano-flakes
Conference Title : ICSEST 2025 : International Conference on Renewable Energy Sources and Technologies
Conference Location : Barcelona, Spain
Conference Dates : March 03-04, 2025