In-situ hydrothermal growth of $Zn_4Si_2O_7(OH)_2 \cdot H_2O$ anchored on 3D N, S-enriched carbon derived from plant biomass for flexible solid-state asymmetrical supercapacitors

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Abstract

Zinc silicates are an appealing feature for electrode materials in Li-ion battery owing to their layered structure providing a well-defined and facile Li ion transportation route. However, the poor conductivity of zinc silicates limits their wide application as electrode materials, and furthermore zinc silicates have not been explored to apply to supercapacitor. Herein, three-dimensional N, S-doped C-$Zn_4Si_2O_7(OH)_2 \cdot H_2O$ (3D C-ZnSi) have been developed by a hydrothermal process from a highly available and recyclable plant biomass - bamboo leaves, composed of organic compound and silica, for the application to supercapacitor. This is about zinc silicate first applied to supercapacitor. The as-prepared electrode materials have extensive pores inherited from biological structures of bamboo leaves, including micropores, mesopores and macropores. Owing to the existence of hierarchical pores, the single electrode presents excellent capacitance of 450 mF cm^{-2} at 5 $mV \cdot s^{-1}$, and excellent cyclic performance with the retention of 83% after 10000 cycles. Furthermore, the as-assembled 3D C-ZnSi//activated carbon (3D C-ZnSi//AC) flexible solid-state asymmetric supercapacitor can achieve a maximum energy density of 0.69 Wh m^{-2}. Additionally, the device exhibits high cycle stability for 6900 cycles with the retention of 80%. This study shows the possibility for 3D N,S doped C-$Zn_4Si_2O_7(OH)_2 \cdot H_2O$ as one of the most promising candidates for high performance energy storage devices.

Keywords: Biomass; Zinc silicate; Supercapacitor; Hierarchical pores; Electrochemical performance