**Abstract**

Developing high-performance positrode materials are essential to attain high energy supercapatteries. In this regard, the electrochemical performances of the hydrothermally synthesized LiMnPO4 are studied. The crystal structures of the materials are elucidated using Full-profile XRD Rietveld refinement. The LiMnPO4 particles showed uniform elongated spherical shape with rice-like morphology. The rice-like LiMnPO4 showed a higher specific capacity of 492 C g−1 at 2 mV s−1 than highly agglomerated particles synthesized through sol–gel thermolysis method (191 C g−1) in 1 M LiOH aqueous electrolyte. The supercapattery is fabricated with rice-like LiMnPO4 and activated carbon (AC) as positrode and negatrode, respectively. The supercapattery (AC||LMP-H) delivered a higher capacitance around 99 F g−1 along with an improved energy density of 31 Wh kg−1. On the other hand, the LiMnPO4 prepared by sol–gel thermolysis method exhibited a very low capacitance of 35 F g−1 at 0.6 mA for the fabricated device (AC||LMP-S) with the lesser energy density about 11 Wh Kg−1 at a power density of 198 W kg−1. The reason behind the improved performance is explained based on the crystal structure as well as lower charge transfer resistance.