Fabrication of Polypyrrole Conductive Matrix covered $MnNi_2O_4$ Nanocomposite as the Positive Electrode Material in Asymmetric Supercapacitors

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1. Materials used

Pyrrole monomer, cetyltrimethyl ammonium bromide (CTAB) and potassium peroxodisulphate (PDS) were received from Merck. $Ni(NO_3)_2.6H_2O$, Manganese acetate and ethanol (C_2H_5OH) were purchased from SRL (India). Acetylene black, polyvinylidene fluoride (PVDF) and N-methyl-2-pyrrolidone (NMP) were received from Merck.

2. Synthesis of $MnNi_2O_4$

Manganese nickel oxide was synthesized via a simple co-precipitation method. First, 0.4 M of $Ni(NO_3)_2.6H_2O$ and 0.2 M of manganese acetate were dissolved separately in 50 ml of water. After that, 0.2 M of manganese acetate was added drop by drop to the 0.4 M $Ni(NO_3)_2.6H_2O$ solution at 60 ^oC for 15 min., then 0.5 M NH_4OH was added drop by drop for an hour under stirred conditions. The precipitate was filtered and washed several times with

water and ethanol, and dried at 80 ^{o}C for 12 h. Finally, the precipitate was calcined at 350 ^{o}C for 3 h. to get a dark-brown colored $MnNi_2O_4$.

3. Synthesis of Polypyrrole (PPY)

25 ml of 0.5 M H_2SO_4, 200 ml of double distilled water, and 0.01 g of CTAB were taken in a beaker and stirred for 1 h in a magnetic stirrer. Then, the beaker was kept in an ice bath, and 5 ml of pyrrole was added, and stirring was continued. To this mixture, 20 ml of 0.8 M of $K_2S_2O_8$ was added dropwise till black coloration developed. Then, the reaction mixture was kept in a stirrer for 6 h. under cold conditions. Further, the product was neutralized with water and filtered. The dried precipitate was powdered and used for further analysis.

4. Materials characterization

The phase configuration and surface functionalities of the as-prepared samples were performed using Bruker (XRD, Rigaku D/maxB, DMX-2200) and Jasco FT-IR-4600 spectroscopy, respectively. The microscopic analysis of the as-prepared samples was done by using Hitachi S-2400 scanning electron microscope equipped with an energy dispersive spectrometer (EDS), and the surface chemistry of the $MnNi_2O_4$/PPY composite was performed using ESCA/Auger Laboratory X-ray photoelectron spectroscopy. Supercapacitor measurements were performed using the Autolab (AUT51770) workstation.

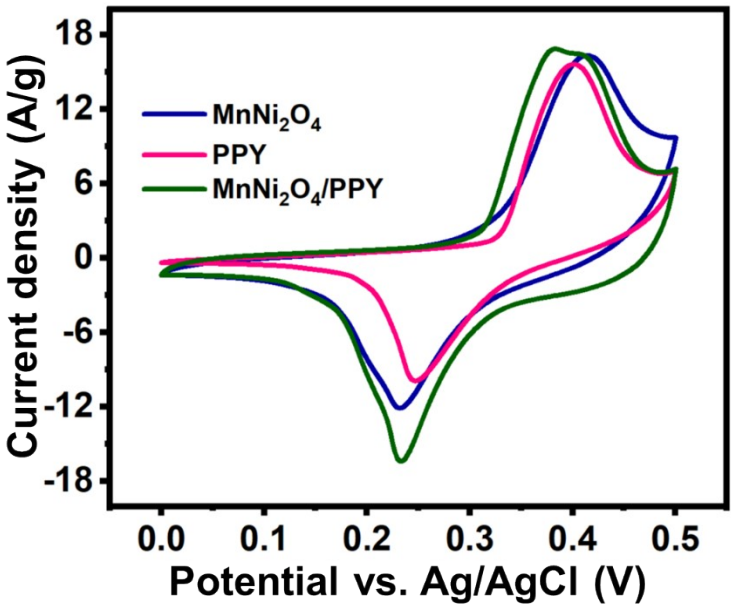

Fig. S1: CV curves of $MnNi_2O_4$, PPY and $MnNi_2O_4$/PPY composite at a scan rate of 5 mV/s in 1 M KOH.

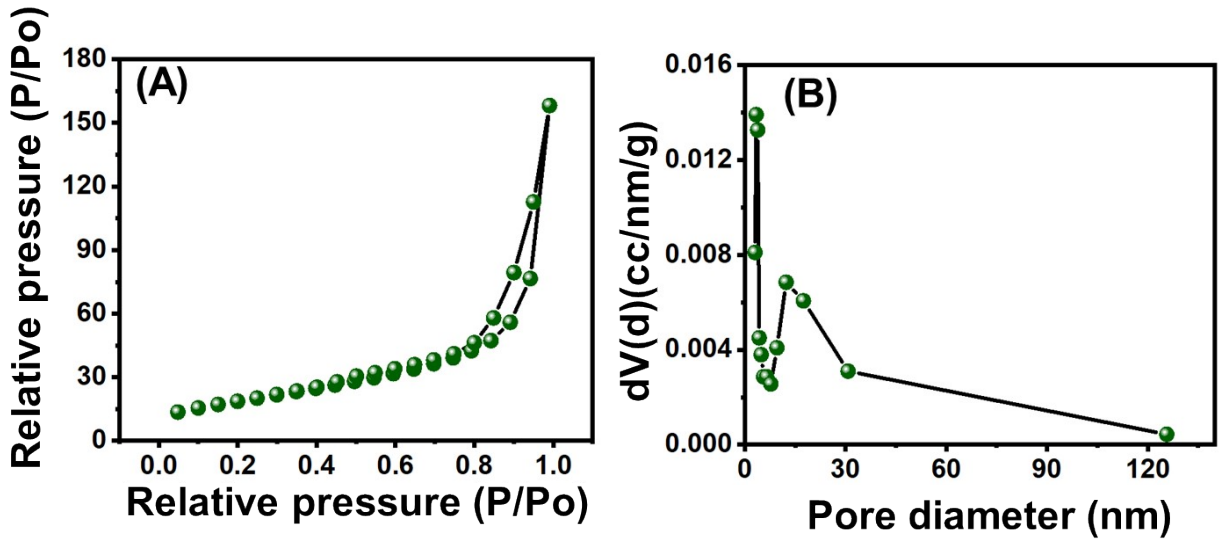

Fig. S2: (A) N_2 adsorption-desorption isotherm curve and (B) corresponding pore size distribution curve of $MnNi_2O_4$/PPY composite.

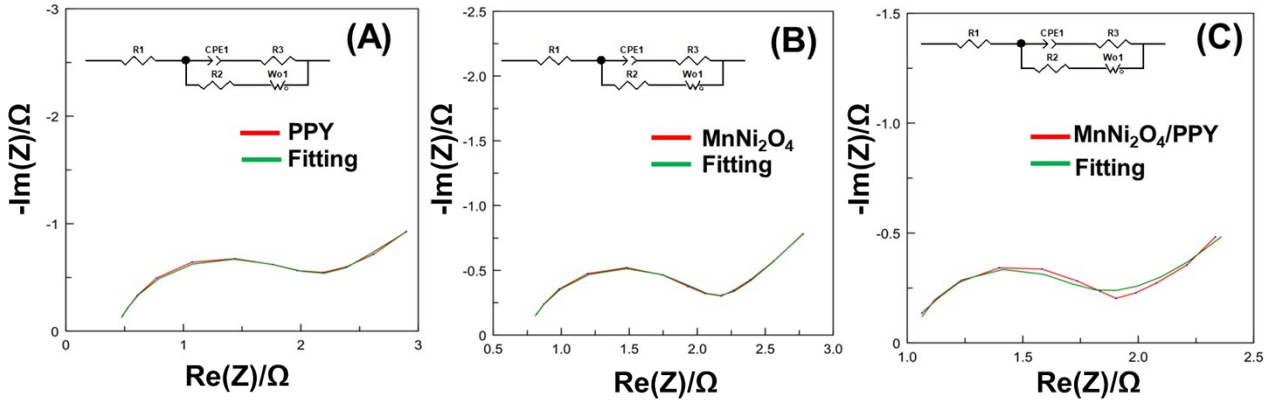

Fig. S3: Nyquist plot of (A)$MnNi_2O_4$, (B)PPY and (C) $MnNi_2O_4$/PPY composite with fittings.