PREPARATION OF FLEXIBLE ELECTRODE COMPOSITE MATERIAL WITH EXPANDED GRAPHITE AND PVAC

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INTRODUCTION

Flexible electrodes are widely used in wearable electronic energy storage devices and flexible capacitors. Therefore, the development of novel low-cost biodegradable electrode materials is important to satisfy the growing market [1]. The main aim of this study is to develop low-cost electrode material from biodegradable polymer composite materials and compare the electrochemical characteristics like resistance and conductivity against mechanical forces. Expanded graphite has a good tendency to form conductive paths after applying high compression force [2].

MATERIALS AND METHOD

Therefore, expanded graphite (EG) was prepared by chemically assisted thermal expansion of Kahatagaha graphite at 700°C, and polyvinyl acetate PVAc was used to prepare the composite mixture. Then the electrode was prepared by compressing EG mixed PVAc composite on the pneumatic press up to a 40-ton load. The prepared composite was characterized using scanning electron microscopy (SEM), X-ray diffraction spectroscopy (XRD), Thermal gravimetric analysis (TGA), and RAMAN spectroscopy. Also, current collecting performance was investigated under different graphite to PVAc ratios.

RESULTS AND DISCUSSION

Structural and morphological investigation

For testing, the flexibility and resistance variation electrodes were subjected to tensile stress. The fabricated current electrode material was further used with Fourier-transform infrared spectroscope (FTIR) and Raman spectroscopy. The best composition for this composite was the PVAc to graphite ratio, which is 1:3, shown in Figure 1 (a). The system reduces the resistance due to higher compressive force which is demonstrated in Figure 1(b).

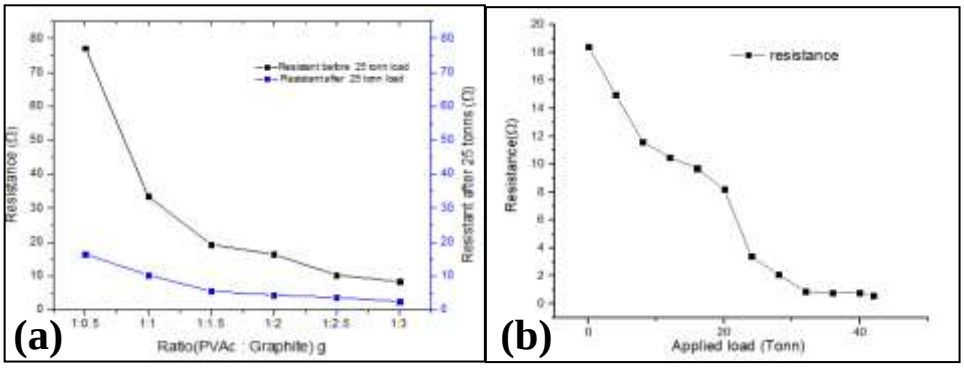

Fig. 1.

Fig. 1(a) Change of resistance with applied 25- ton load for different compositions of PVAc and Expanded Graphite (b) Change of resistance with different applied compressive forces

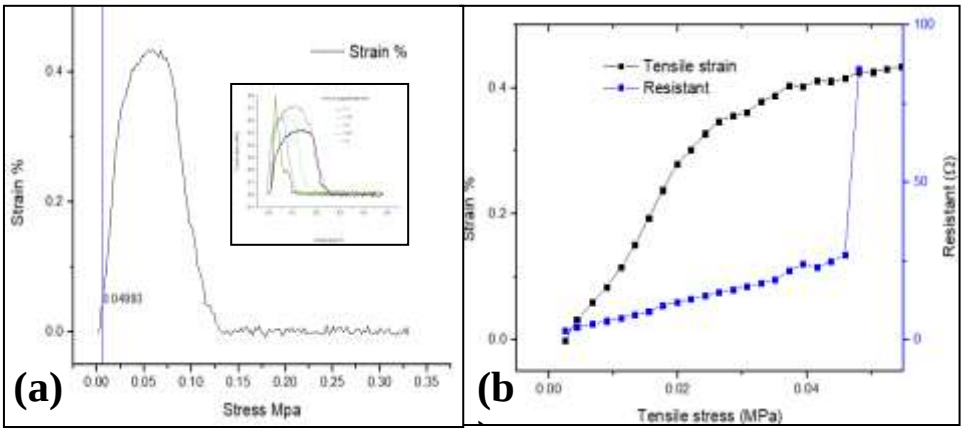

Fig. 2.

Fig. 2 (a) Change of resistance with applied 25-ton load for different compositions of PVAc and Expanded Graphite Fig. 2 (b) Change of resistance with different applied compressive forces.

Fig. 2(a) shows the strain on the material after applying different stress. The best composition for electrodes is the lowest resistance at higher strain. Fig. 2(b) shows the maximum strain attained before breaking and the maximum resistance at the breaking point.

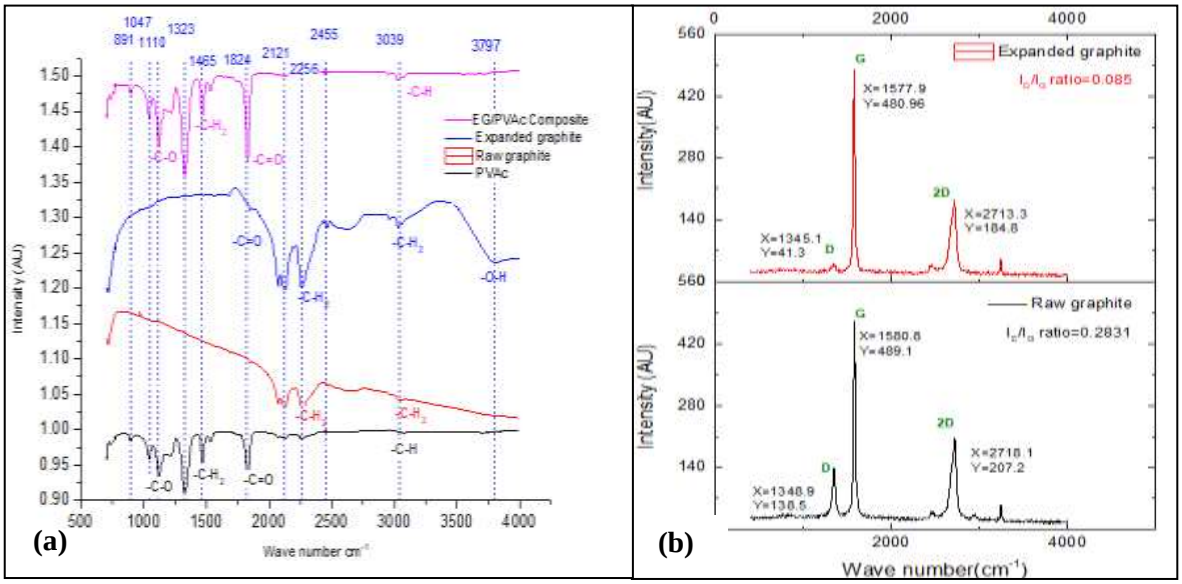

Fig. 3

Fig. 3 (a) FTIR spectra of graphite and expanded graphite, Fig.(b) Raman spectra of graphite and expanded graphite.

In Fig.3(a), the band at 3700 cm^{-1} can be attributed to the -OH stretching vibration of phenolic or alcoholic functional groups on Expanded Graphite (EG). EG showed a broad and intense peak (compared to raw graphite) at 3797 cm^{-1} due to a large number of -OH groups attached to the surface of raw graphite during functionalization. In Fig.3(b), the G peak, which is found at around 1580 cm^{-1}, is due to the bond stretching of all pairs of sp^2 atoms in both rings and chains. The D peak, which is found at 1348 cm^{-1}, is due to the breathing modes of sp^2 atoms in rings.

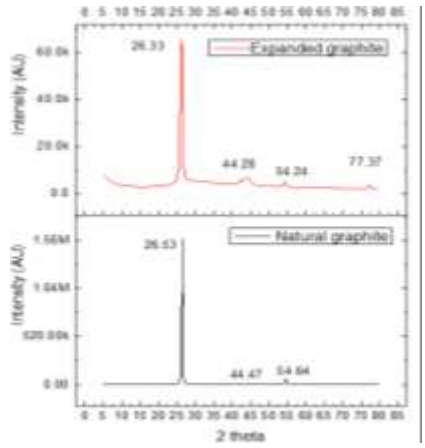

Figure 4 (a), XRD Pattern of graphite and Expanded Graphite

The crystalline nature of EG is closely evidenced by the two peaks at 2 theta = 26 and 54. For EG, the (002) peak of EG was shifted towards a lower angle to 24.33 with a reduced intensity which corresponds to increased interlayer spacing and decreased crystallinity of EG.

CONCLUSION

The $HClO_4$–GIC with the maximum expanded volume EV of 540 cm^3 /g has been synthesized with the chemical method by using NG, $HClO_4$, and HNO_3 as host materials in previous research. According to previous studies optimum conditions, the reaction temperature, time, exfoliating temperature, and the ratio between NFG, $HClO_4$, and HNO_3 are 1/4/0.15 at 1173 K 15 min [3]. In this study, intercalation ratios are NG, $HClO_4$ and HNO_3 are 837.15 K, 5 min, and 1/2/1.5 ratios. The $HClO_4^-$GIC with the maximum expanded volume EV of 480 cm^3 /g was shown in this study. The lowest resistance obtained from the EG/PVAc system was 0.635 Ohms and the material ratio of EG to PVAc was 1:2.5 at a 40-ton compressive force. The PVAc EG electrodes can be used for applications like biosensors due to their low cost and higher flexibility.

ACKNOWLEDGEMENT

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