Graphene modified graphite felts as effective electrodes in the positive half-cell of vanadium redox flow batteries

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Abstract

Vanadium Redox Flow Batteries (VRFBs) have emerged as promising energy storage systems [1]. Although they store energy through the chemical changes of the electroactive species dissolved in two separate solutions, the selection of proper electrode materials is of fundamental importance in order to maximize their efficiency [2]. With this aim, this work proposes graphene modified graphite felts (G-GFs) as low cost, easy to handle and more efficient active electrode materials for VRFBs.

Two G-GFs were prepared following an electrophoretical deposition (EPD) method. Firstly, two pieces of GF were immersed in home-made cells containing a graphene oxide (GO) suspension of 3 (3G-GF) or 6 (6G-GF) mg/mL and a voltage of 10 V was applied for 3 h. Then, the samples were dried at 100ºC and electrochemically reduced in KOH 3M by means of cyclic voltammetry (CV) experiments. In addition, a commonly utilized electrode material (thermally treated graphite felt, TTGF) was used for comparative purposes. The electrochemical performance of the materials as positive electrodes in a VRFB was studied by means of CV experiments in a Teflon three electrode cell where GF, TTGF and G-GFs were the working electrodes (disk-shaped, 1 cm^2 of exposed area). As electrolyte a 0.05M $VOSO_4$/1.0M H_2SO_4 solution was used.

The better electrochemical activity (mainly in terms of the overpotential of the redox reactions) and reversibility on the G-GFs electrodes (Fig. 1) could be attributed to the presence of the graphene sheets, which lead to a higher electrical conductivity and an increased heterogeneous electron transfer rate. Moreover, the increased surface area of 6G-GF may improve the I_p of the vanadium reactions in a real flow system, without the diffusion limitations existing in our static test device.

Thus, taking advantages of both graphite felts and graphenes, we produced more effective electrode materials for the positive half-cell of a VRFB which would contribute to the development of batteries with higher energy efficiencies.

References

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[2] V. Haddadi-Asl, M. Kazacos, M. Skyllas-Kazacos, J. Appl. Electrochem. 25 (1995) 29.

Figures

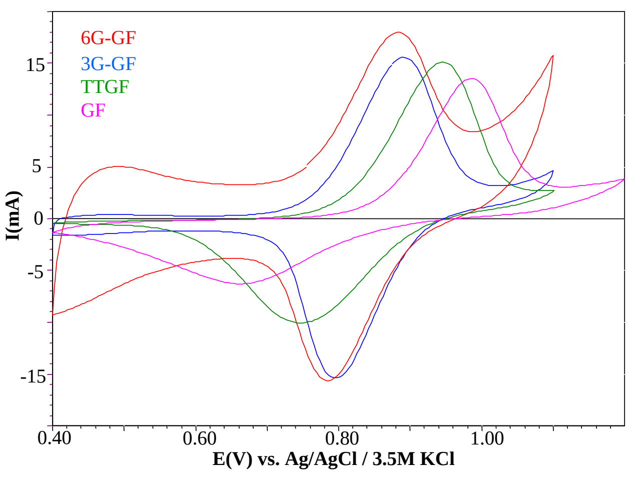

Fig. 1 CVs recorded on the materials at 1 mVs^{-1}