Modification of Expanded Mesocarbon Microbeads with Nickel Oxide Nanoflakes as an Anode Material for Lithium-ion Batteries

Xin-An Chen [a], Mao-Sung Wu [a]
[a] *National Kaohsiung University of Applied Sciences*

The expanded mesocarbon microbeads (eMCMB) were prepared by chemical oxidation of the commercial mesocarbon microbeads (MCMB) followed by heat treatment at 300°C in air. The spacing between graphitic layers in eMCMB was significantly increased after expansion as compared with pristine MCMB, which was in favor of diffusion of the electrolyte and thus enhanced the storage capacity of lithium ions. The eMCMB particles were deposited on stainless steel substrate by electrophoretic deposition method as an electrode for lithium storage. As revealed in Fig. 1a, the reversible capacity of eMCMB electrode in the first cycle reached 650 mAh g^{-1}, which was higher than that of traditional MCMB electrodes. However, the eMCMB electrode exhibited a large irreversible capacity in the first cycle due to the excessive SEI (solid-electrolyte interphase) formation. The lithiation and de-lithiation of eMCMB involved two different processes: the intercalation/de-intercalation and adsorption/desorption, while the traditional MCMB stored lithium primarily through intercalation/de-intercalation. However, the graphene sheets in eMCMBs were easily restacked and the compact stacking of graphene sheets hindered the transport of electrolyte leading to a significant decrease in the specific capacity. To further increase the reversible capacity, the eMCMB electrode was coated with nickel oxide nanoflakes by hydrothermal method followed by heat treatment at 300°C in air. As can be seen from Fig. 1b, the SEM (scanning electron microscope) micrograph revealed that the eMCMB particle was homogeneously coated with a layer of nickel oxide nanoflakes. In addition, the nickel oxide acted not only as a spacer to prevent the graphene sheets from restacking, but also a lithium-storage material to store extra capacity. Thus, the eMCMB electrode with modified nickel oxide nanoflakes exhibited a reversible capacity of about 750 mAh g^{-1} and low irreversible capacity in the first lithiation/de-lithiation cycle, better than the bare eMCMB electrode.

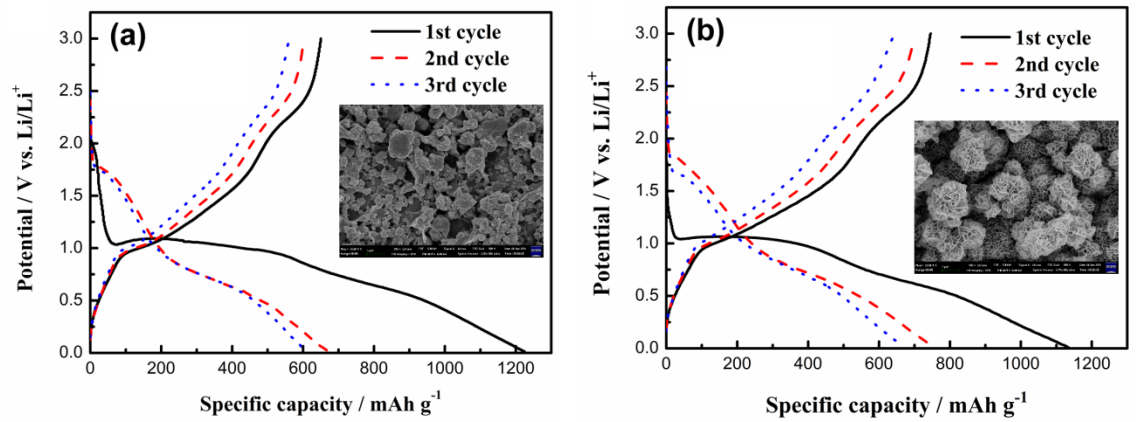

Fig. 1 Lithiation/de-lithiation curves and SEM micrographs of (a) eMCMB electrode and (b) eMCMB electrode with modified nickel oxide nanoflakes.