Pseudo-capacitive Behavior of Graphene Oxide Paper in AlCl_3 and 1-ethyl-3-methylimidazolium Chloride (Molar Ratio of 1.3:1) Solution and its Application for Aluminium Ion Batteries

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Graphene-based materials are cathodes of Al-ion batteries and have attracted the attention of researchers worldwide. However, reasons for self-discharge in Al/graphene batteries have not been studied in depth. In the present work, a pseudo-capacitive reaction is proposed to be a probable cause of the self-discharge. Quantitative analysis of the capacitance process and diffusion-control process is critical for the pseudo-capacitive behavior in Al/graphene batteries. Two self-supported graphene cathodes (R_H -GOP and R_N -GOP) were successfully produced from graphene oxides (GO) reduced with hydriodic acid and hydrazine vapor, respectively. R_H -GOP and R_N -GOP cathodes enabled the delivery of considerably high specific capacities of 81.5 mAh g^{-1} and 92.8 mAh g^{-1} , at the current density of 2 A g^{-1} . In addition, the activation processes of both materials were observed during 200 cycles of the charge-discharge process. From a quantitative perspective, the ratios of faradaic pseudo-capacitance to the total capacity of the R_H -GOP and R_N -GOP cathode were 48.6% and 38.5%, respectively, at a scanning rate of 5.0 mV s^{-1} . It is found that the proportion of faradaic pseudo-capacitance will increase as cyclic voltammetry scanning increases, which indicates the existence of pseudo-capacitance being the reason why it an Al/graphene battery has to be charged-discharged at high current densities to maintain normal operation.

Keywords: Al-ion battery; Oxide graphene paper; Cathode; Pseudocapacitive; self-discharge

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