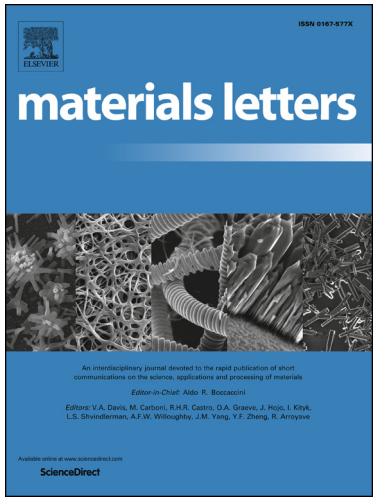

Charge Transfer Resistance of Copper and Nickel Thin Film Electrodes in Nano dimensions

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Charge Transfer Resistance of Copper and Nickel Thin Film Electrodes in Nano dimensions

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Abstract

Cu and Ni films with thickness ranging from 10 to 200 nm were sputter deposited and their electrochemical impedance was investigated by impedance spectrum to develop the relationship between thickness of thin film electrodes and interface electrochemistry. Both charge transfer resistance and double layer capacitance of the film electrodes decreased with increase in thickness of the thin film electrodes. The current work provided further understanding on interface electrochemistry of thin film electrodes and served as guidance for the design of high performance miniature electrochemical devices.

Keywords: metal films; electrode; energy storage; charge transfer resistance

1. Introduction

Due to their special advantages in mechanics,[1] electrical transport,[2] etc., metals and alloys in nanoscale dimensions have attracted significant attentions in fields such as high performance catalyst,[3] microelectronics,[4] microsensor,[5] and miniature supercapacitors.[6] Dimension is a key factor in determining the performance of various devices. For example, lithium ion batteries have high energy density but slow charge/discharge processes. Meanwhile, their active ion diffusion is limited by the electrode thickness.[7] Metal film electrodes are of significant necessity to reduce internal resistance and polarization in lithium ion batteries.[8]

Charge transfer is a core step in electrochemical processes. Small charge transfer resistance means a fast charge transfer process and a high power density. Diversity in structure and properties of electrode materials leads to significant difference in their charge transfer resistance. As a result, charge transfer resistance is usually used as an auxiliary parameter for evaluation of system performances. In the current work, Cu and Ni thin films in nano-dimensions were prepared and their charge transfer resistance was investigated. The relationship between the charge transfer resistance and film thickness is established to develop understanding on the performance of microelectrochemical systems for design and fabrication of high performance miniature electrochemical devices. To our best knowledge, this is the first report to study the relationship between thickness of metal thin film electrodes and their charge transfer resistance.