Accepted Manuscript

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PII: S0013-4686(18)30490-0

DOI: 10.1016/j.electacta.2018.03.002

Reference: EA 31368

To appear in: *Electrochimica Acta*

Received Date: 27 December 2017

Revised Date: 1 March 2018

Accepted Date: 1 March 2018

Please cite this article as: H. Xie, H. Zhao, J. Liao, H. Yin, A.J. Bard, Electrochemically controllable coating of functional silicon film on carbon materials, *Electrochimica Acta* (2018), doi: 10.1016/j.electacta.2018.03.002.

Electrochemically controllable coating of functional silicon film on carbon materials

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Abstract: A silicon deposit of various forms was successfully coated on graphite by electrodeposition in molten $CaCl_2$ containing nano-SiO_2 as a silicon precursor. The morphologies of the deposited silicon can be tuned from Si nanowires to a dense film by controlling constant electrolysis cell voltage. In addition to controlling electrochemical polarizations, the substrate plays a key role in forming a dense silicon film. By analyzing the interface between the Si film and graphite substrate, a thin transition layer comprising of Si, SiC and C enables the good adhesion of the Si film with the carbon substrate and thereby helps the growth of a dense Si film. Besides the application for photovoltaics, the electrolytic p-type Si film was employed as a binder-free anode for lithium ion batteries delivering a capacity of over 2500 mAh g^{-1} in the first 10 cycles and retaining 800 mAh g^{-1} after 40 cycles. Moreover, this method was applied for coating Si on carbon fibers, which could be a general way to prepare Si with controllable forms and silicon/carbon core-shell structures for functional materials.

Keywords: silicon film, electrodeposition, molten salts, carbon substrate, anode materials