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Flexible nanoporous titania/silica hybrid electrodes for lithium-ion batteries

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Stable and safe lithium-ion batteries with high capacity are a current research area of great importance due to its applications in electric vehicles and flexible portable electric devices. Using the sol-gel method, TiO2/SiO2 nanostructured hybrid electrodes were prepared using polystyrene-block-polyethylene oxide (PS-b-PEO) di-block copolymer as a guiding template. The current study showed the possibility to fine tune the TiO2/SiO2 nanoporous electrode morphologies, especially both pore size and pore-to-pore distance. An experimental method to achieve extremely flexible with additional very high flexural endurance freestanding nanoporous hybrid thin film electrodes is described. Thin film of gold metal current collector was further deposited on the TiO2/SiO2 nanoporous hybrid thin film. In situ grazing incidence small angle X-ray scattering (GISAXS) was employed to investigate the nanoscale structure of the metal contact film during metal deposition in a real-time mode. The GISAXS 2D patterns showed distorted powder-like Debye-Scherrer (DS) elliptic half rings which are attributed to the intrinsic hexagonally ordered nanopores arrangement in the TiO2/SiO2 hybrid electrodes. The real time GISAXS study proves a preferential deposition of gold in the near surface pores, forming vertically oriented gold metal nanorods. From the current results, a possible future implementation of these free-standing anodes in flexible lithium-ion battery applications is potentially foreseen.

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