ABSTRACT TEMPLATE
20th International Balkan Workshop on Applied Physics and Materials Science
Constanta, Romania 12-15 July 2022

Plenary [ ] Invited lecture [X] Oral presentation [ ] Poster [ ]

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SILICON NANOMATERIALS FOR ENERGY STORAGE

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Studies on emerging energy conversion and electro-chemical storage technologies are determining to solve the economic, social and environmental challenges of the energy sector. Silicon has been in the spotlight of the next generation anode materials for Li-ion battery industry due to its distinctive Li-related features such as the ability to form lithium rich compounds, corresponding to an exceptional capacity of 3579 mAh/g at low working voltages. In exchange, many engineering challenges are associated to the structural deformation during lithium alloying that can lead to material pulverization as well as limited cycling life.

We'll detail on an anode configuration accommodating interconnected kinked Si nanowires fabricated by metal assisted chemical etching. We'll emphasize the importance of the metal assisted chemical etching method for the synthesis of advanced Si nanostructures. The electrochemical evaluation of the three-dimensional kinked Si nanowire-based anode assemblies shows valuable cycling life in ionic liquids compared to conventional electrolytes, retaining 80% of the initial capacity and displaying an average Coulombic efficiency of 98% after 100 cycles. We'll report on three-dimensional interconnected Si-based aerogel systems relying on silicon nanoparticles trapped within highly porous, electronically active multi- walled carbon nanotube frameworks as Li-ion battery anodes. We'll further focus on flexible Li-ion batteries and analyze nanotechnology approaches for improving their performances via Si-built anodes. An approach to roll out Li-ion battery components from silicon chips by a continuous and repeatable etch-infiltrate-peel cycle will be presented. Using this procedure we demonstrated an operational 3.4 V Li-polymer metal@silicon nanowire battery, which is mechanically flexible and scalable to large dimensions. The influence of the metal shell morphology and thickness on swelling and fracture modes of the crystalline silicon nanowires will also be presented.

Silicon-based materials and their derivatives have attracted considerable attention as electrode materials in supercapacitors and hybrid supercapacitor-battery devices with favorable performances due to the facile integration with electronics, non- toxicity and well-established procedures across the entire value chain. For instance, high-voltage microsupercapacitors based on Si nanostructures require optimized electrolytes to improve the energy density of supercapacitors compared to Li-ion batteries. We'll present our recent efforts towards all-solid state, high-voltage microsupercapacitors with recycled Si-based nanomaterials for enabling circular economy approaches for smart energy storage systems.

The support of Fonds Européen de développement régional (FEDER) and the Walloon region under the Operational Program "Wallonia-2020.EU" (project CLEARPOWER) is gratefully acknowledged. This work was supported by the Belgian F.R.S. – FNRS under the grants n° T.0106.16 and R.8016.21.

Keywords: Silicon nanowires, electrolytes, Li-ion batteries, supercapacitors.