M-ERA NET 3 workshop

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Bio-based materials for Li-ion batteries

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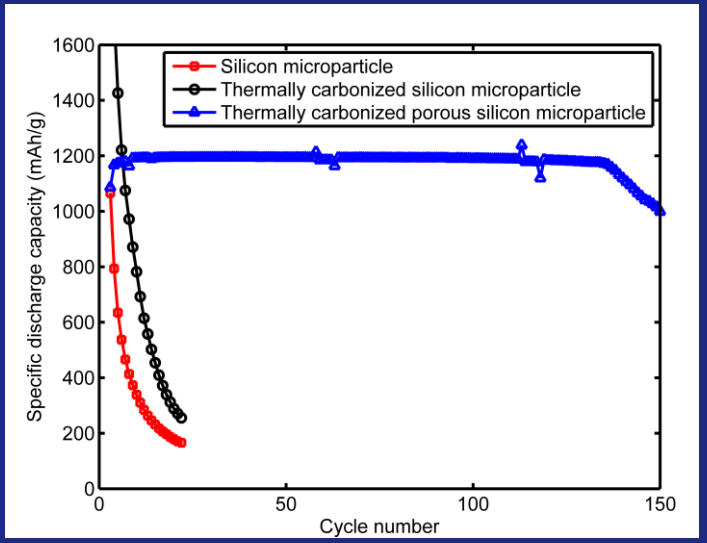
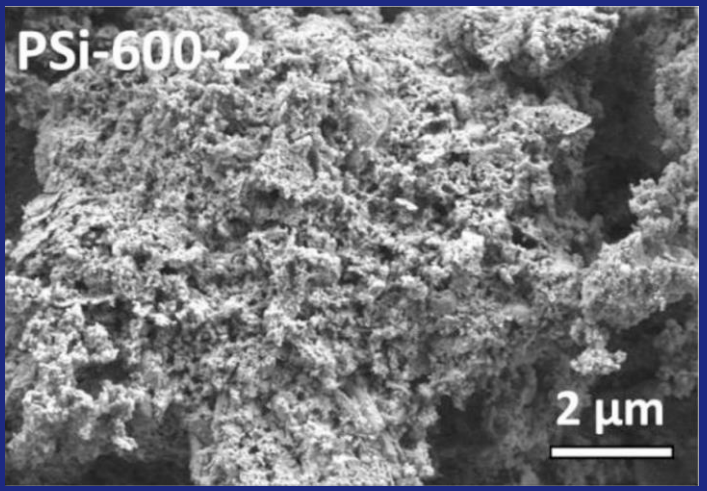
Background

- Volume change (300%) of Si during lithiation/delithiation cycles → stresses → cracking → loss of contact → fast decrease in performance (DOI:10.1088/1361-6528/abb850).
- Mesoporous structure of Si accommodates the volume change and alleviates the effects of cracking (DOI:10.1038/s41598-020-62564-0).
- The wisdom of nature can be utilized to produce mesoporous Si from bio-source, exploiting inherent structure for increased porosity (DOI:10.1016/j.matchemphys.2020.122736).
- The problem related to unstable SEI layer remains → due to the consumption of the electrolyte, the life cycling data is poor
- Future of battery technology should incorporate more green materials for circular economy → extracting value and materials from waste streams and byproducts

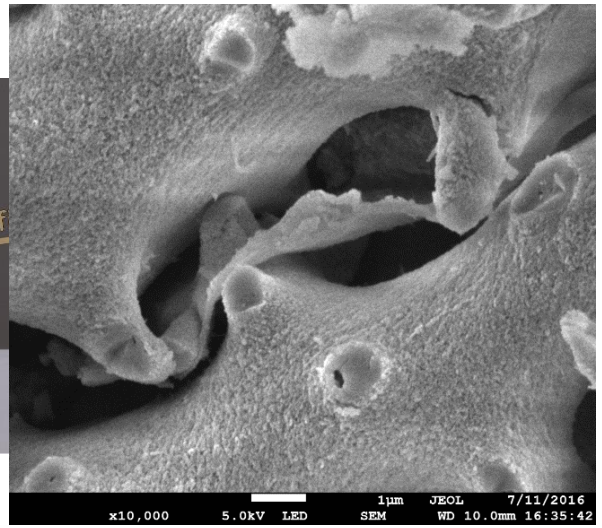




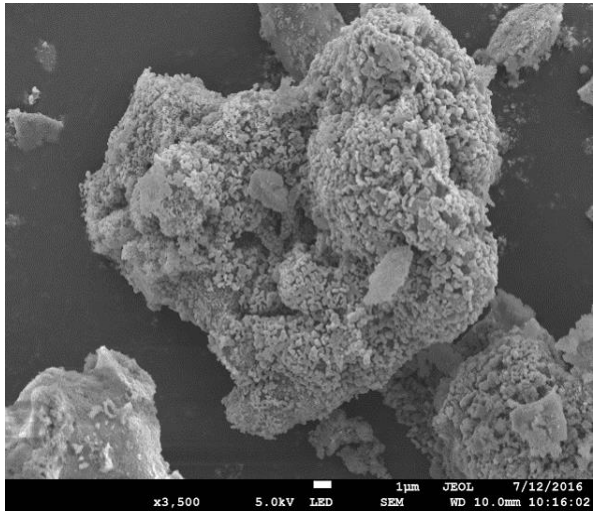
Project objectives and approach

- **Objective:** to develop a bio-sourced, bio-templated battery
- Bio-silicon anode: reduced phytoliths
- Cellulose-based binder
- Environmentally-friendly lithium metal phosphate cathode
- Other bio-based aspects

Before reduction: phytolith



After reduction: porous silicon



- Overcoming anticipated challenges (depending on consortium partners):
  - Passivating the Si surface with oxide/carbide/carbon
  - Developing or screening electrolytes suitable for passivated Si surface
  - Applying self-healing conductive polymer coating
  - Free-standing cellulosic current collectors

Project organization

- WP1: Bio-sourced porous Si and surface passivation
- WP2: Electrode development (Si-C composite, binders)
- WP3: Development of electrolyte/self-healing polymer/other bio-aspect
- WP4: Optimization of battery assembly (incl. commercial cathode)
- WP5: Life cycle and cost analysis
- WP6: Project management

Project scope:

- Target TRL 2-3 to 4-5, depending on scientific vs. development objectives
- Consortium size: 4 to 5 partners
- Target application: grid-scale energy storage

Thank you for your attention!

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