

Addressing Interfacial Degradation at Hard Carbon Anodes of Sodium-Ion Batteries

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Research Question: What specific material properties of hard carbon directly affect interfacial degradation at hard carbon anodes?

Introduction:

Sodium-ion batteries (SIBs) have become a promising alternative to lithium-ion batteries but have yet to reach the same level of success in performance due to degradation at the anode surface after use. The goal is to understand which material properties of hard carbon contribute the most to interfacial degradation when serving as an anode for SIBs. This project investigates a selection material properties in various hard carbon powders and comparing it to their subsequent performance as an anode.

Materials and Methods:

- ❖ 3 hard carbon powders were utilized in this study from 3 different suppliers: MSE Pro, Unigrid and MTI.
- ❖ For each powder, the porosity, convexity, and circularity was found and compared to the performance when used as an anode in SIBs to identify any observable trends between their performance and physical properties.

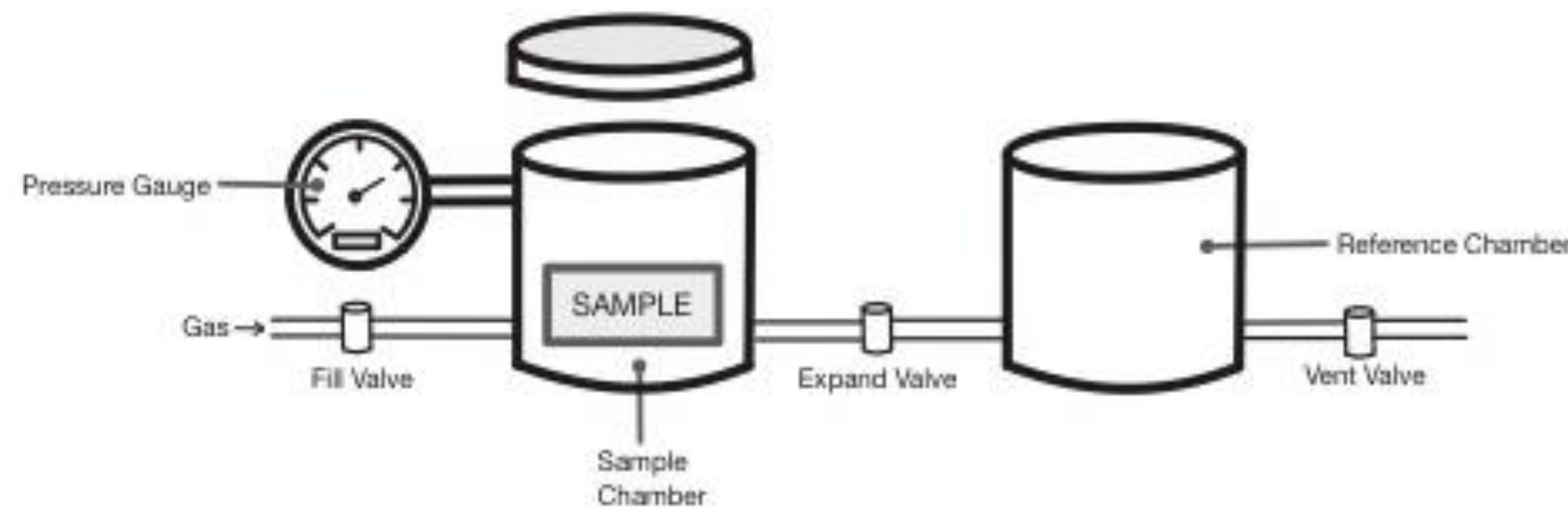
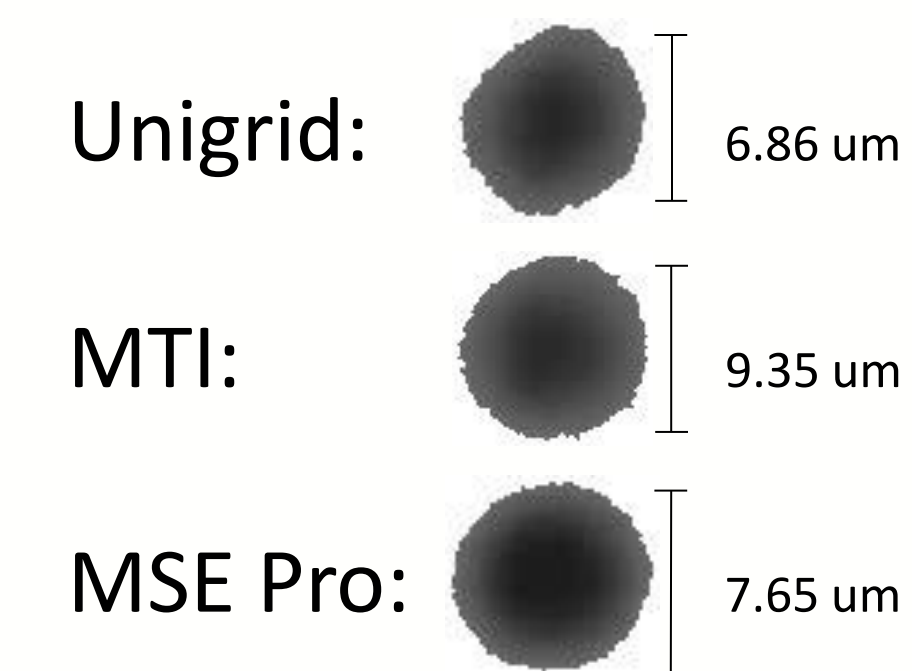
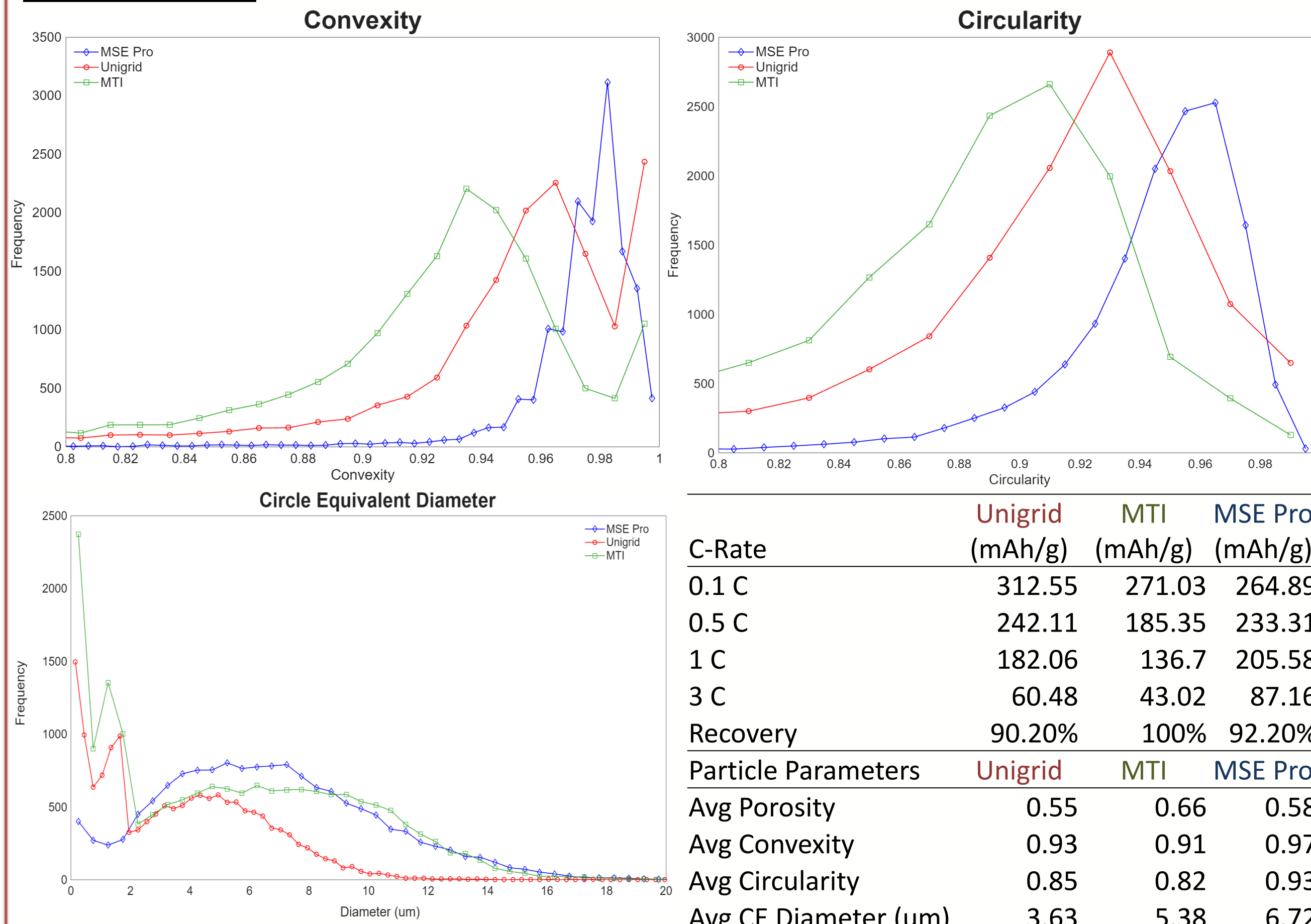


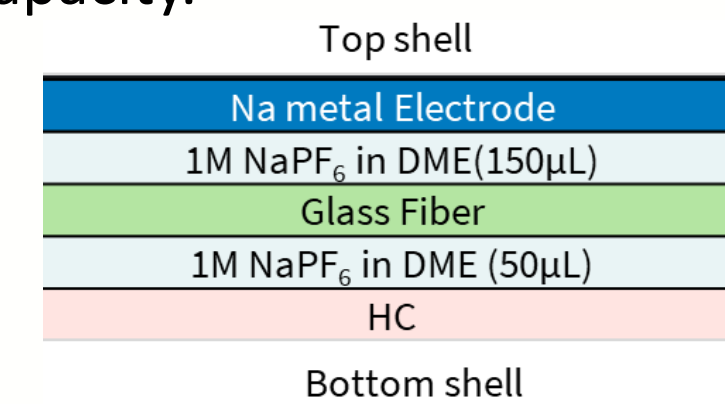
Figure 1: Particle Images taken from Malvern Microscope. Figure 2: Gas pycnometry apparatus within the AccuPyc II 1340 pycnometer.

- ❖ To measure the porosity, the Micromeritics AccuPyc II 1340 was utilized to obtain the skeletal density of each powder by applying Boyle's Law.
- ❖ For the convexity and circularity, the Malvern Morphology Particle Microscope measured the different particle parameters while also obtaining images for every particle within each $\sim 1 \text{ mm}^3$ sample.

Results:



C-Rate is the charge/discharge rate, defined as 1 Ampere per hour. It measures the speed of the charge/discharge rate of the battery relative to the total capacity.



- ❖ At lower C-Rates, the Unigrid HC Powder consistently performed better than the other 2 HC powders, which could be a result of the smaller and narrower size range compared to MTI and MSE.
- ❖ For higher C-rates the MSE powder performs better under more intense C-rates possibly from having the greatest convexity (roughness) and circularity compared to the other powders.
- ❖ The MTI powder had the highest recovery, which could be due to the porosity of the powder as MTI has the greatest volume fraction compared to the other powders, meaning increased movement and accessible storage for Na^+ ions.



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