Conclusions

Heat sample in furnace at varying Lme and temperatures

Forma.on Process:
- The electrochemical performance is determined by cycling coin-type half-cells. Characterized using X-ray diffracLon (XRD) and scanning electron microscopy (SEM) analyzed as a funcLon to treatment temperature and molarity. Samples are treated.

Morphology, crystallinity, and electrochemical performance are similariLes to lithium, sodium-ion ba.ries (NIBs) present one likely alternative to lithium are steering research toward alternaLes for rechargeable ba.ries from cell phones to electric cars, but concerns about scarcity and the price of lithium are increasing. Need for rechargeable ba.ries.

Hydrochloric Acid
- Sodium Hydroxide Pellets (Sigma Aldrich)
- Used to determine the structure of the samples

FEI Teneo Field Emission Scanning Electron Microscope (FESEM)

Dry in vacuum oven at 100°C

Mix NaOH + Anatase TiO2 Powder

Hydrothermal Treatment

Conifuge

Washing with HCl + DI water

Figure 1: Formation mechanism of TiO2 nanotubes via the hydrothermal process

Materials & Methods

Materials:
- Titanium(IV) oxide, 32 nm powder, 45m2/g (Alfa Aesar)
- Sodium Hydroxide Pellets (Sigma Aldrich)
- Hydrochloric Acid

Formation Process:

Figure 6: Outline of samples made over the summer

Objective: To understand the effects of temperature and base concentration of the formation of titane nanotubes.

20 Hour Hydrothermal Treatment:

Figure 7: XRD characterization of sample AS1_10_6 which used 10M NaOH and was treated at 250°C. The product was a combination of sodium titane, anatase TiO2, and sodium chloride.

Figure 8: XRD plots of AS1_10_6 and AS1_10_8, made at 250°C with 10M and 12M NaOH (respectively) show clear phase differences. Interestingly, the SEM images (inset) show very similar structures.

Figure 9: FESEM image of sample AS1_10_8, synthesized with 12M NaOH at 250°C. Large needle-like shapes (avg. diameter 215 nm) were formed, indicating the presence of nanotubes/wires/rods. Some unreacted precursor material is visible.

Objective: To successfully synthesize anatase TiO2 nanotubes according to the methods described in [1].

XRD results for sample AS1_16_5 showed a mostly amorphous product with an unidentified impurity phase.

Figure 11: FESEM image of sample AS1_16_5, synthesized at 110°C with 10M NaOH. Demonstrates the amorphous structure of the material.

Figure 12: FESEM image of sample AS1_16_5, synthesized at 110°C with 10M NaOH. Shows no nanotube formation. Sample appears less porous than other low temperature samples.

Materials & Methods

Methods:
- Combine titane precursor with sodium hydroxide and transfer to reactor vessel
- Heat sample in furnace at varying time and temperatures
- Centrifuge to separate particles and dry overnight under vacuum

Characterization:
- Rigaku Miniflex 600 X-Ray Diffractometer (XRD)
  - used to determine the phase and composition of the samples
- FEI Teneo Field Emission Scanning Electron Microscope (FESEM)
  - used to determine the structure (nanotubes, scrolls, etc.) of the samples

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