TURBOSTRATIC GRAPHENE AS HIGH PERFORMANCE CATHODE IN AL-ION CELL

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INTRODUCTION

Goal

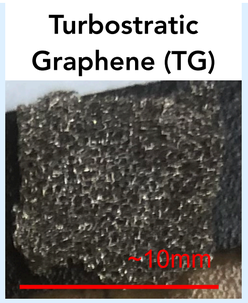
Synthesize, characterize, and implement rotationally disordered graphene (turbostratic graphene) as a cost effective cathode material in an Al-ion battery cell for enhanced performance compared to graphite and orderly-stacked graphene cathodes. Turbostratic graphene has promising attributes for a cathode, such as enhanced conductivity and larger interplanar spacing.

Motivation

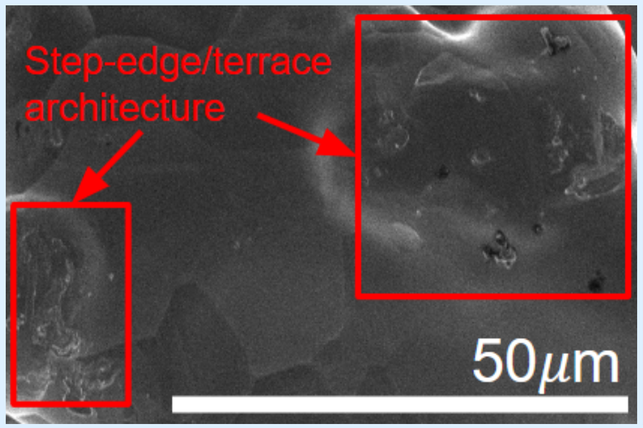
- **Produce more energy and capacity**
- **Meet higher energy demands at lower costs**
- **Improve safety to prevent injury**
- **Lower environmental impact**

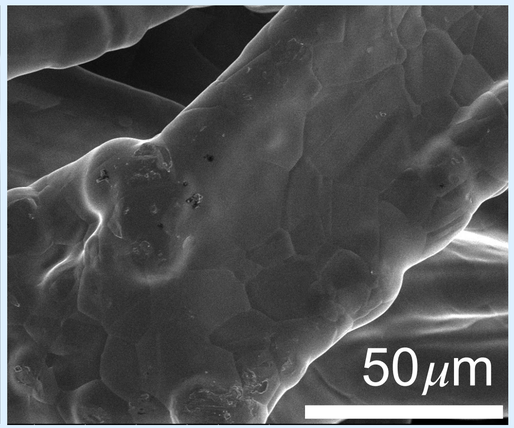
Responsibility	Person	Wk 1	Wk 2	Wk 3	Wk 4	Wk 5	Wk 6
Synthesis of Materials							
Turbostratic Graphene	KN						
Et3NHCl Electrolyte	TS						
3DTG Characterization							
Optical Microscopy	CM						
Raman	KN						
XRD	CM						
SEM	CM						
Cell Fabrication							
Swagelok	TS						
Cell Design	KN						
Cell Performance Test							
CV	TS						
Charge-Discharge	TS						

RESEARCH AND PROTOCOL

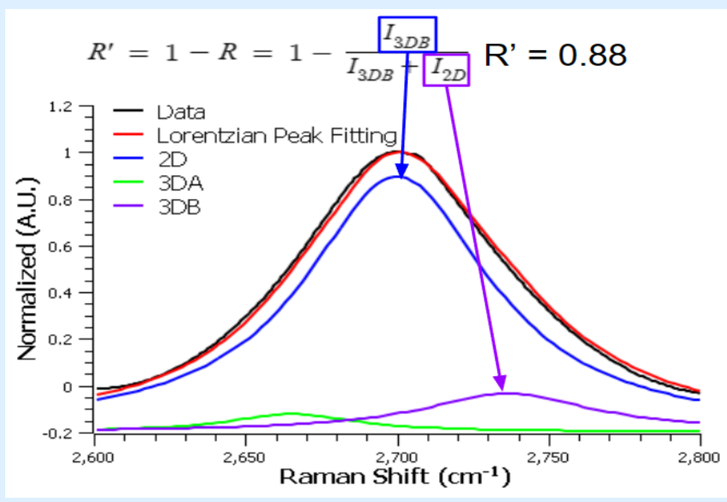


Chemical vapor deposition is utilized to synthesize graphene on Ni foams, via both diffusion-precipitation and surface adsorption growth mechanisms. CH_4 is utilized as the precursor gas, H_2 as a reducing gas to prevent oxidation of the Ni surface, and Ar gas as a carrier gas for the precursor reducing agent into the reaction chamber and byproducts out.

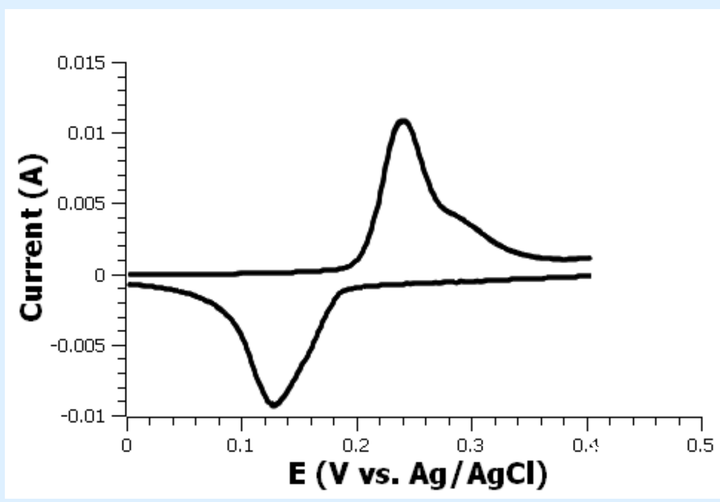




Scanning Electron Microscopy produces images using a secondary electron detector with 5-kv with 13.3pA, characterizes step-edges and terraces on the Ni surface, which facilitate stacking mismatching between graphene layers.



Raman spectroscopy allows us to examine the behavior of coupons' atomic vibrations, and whether they behave as orderly or disorderly stacked graphene. This is done by studying the ratio of the intensity of the 2D peak (2550-2850 cm^{-1}) and it's right shoulder (R'), with values approaching 1 corresponding to complete turbostraticity and values approaching 0 as complete ordered stacking.



Cyclic Voltammetry is the potential sweeping of an electrochemical cell to measure the current produced under conditions, during charging and discharging. The graph for a AgCl cell, the top oxidative peak indicates ~12mA produced by ~0.225 V during discharge, and the bottom reductive peak indicates 0.125 V needed to produce a max current of 9mA to charge cell

FUTURE WORKS

Proto Cell Analysis

Performance Metrics
Energy Density: amount of energy per gram of mass
Onset Potential: the minimum or maximum potential values at which current is produced
Capacity: amount of current generated over a defined amount of time
Coloumbic efficiency: the ratio of electron transfer in forward and reverse reactions
Charge Cycle: estimate of a battery's overall lifespan

Future Tests
Raman Mapping: Examine TG coverage over an area of the foam
Xray Diffraction: provide crystallographic structure and chemical composition
Charge-discharge testing: determine number of times a battery can be used until it deteriorates

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