1T-MoS₂ Fibers for Flexible Energy Storage: A Bit of a Stretch?

Lucija Koledic, Sophie Mance, Dr. Ye Wang*, Prof. Manish Chhowalla*

1. Introduction

Abstract & Motivation

The rapid growth of portable electronics calls for the development of flexible components, including the power supply unit. Fiber-shaped materials exhibit the potential to be incorporated into woven textiles ideal for wearable devices.

In this work, we develop a strategy for forming flexible anode materials from fibers of two-dimensional (2D) materials. These two-dimensional nanosheets form thin fibers in a coagulation bath, reaching diameters down to 100 μm. The fibers show high conductivity up to 4.8 Siemens/meter, demonstrating their potential for future applications in flexible batteries.

2. Methods and Results

2.1. Intercalation assisted exfoliated 1T MoS₂ (Li-MoS₂): Top-down approach

1. Li-intercalation assisted exfoliated 1T MoS₂ (Li-MoS₂): Top-down approach

1.1. Fabrication of Fibers via Coagulation

- 1. Gel Formation
  - Sol-gel synthesis
  - Material must surpass certain concentration to be successfully spun due to Onsager's theory:
  - Liquid crystals (LC) approximated as hard rods will transition from isotropic to nematic as LC density increases.
  - Can extend to high alignment in 2D materials, which similarly have a high aspect ratio.

- 2. Extruding gel in coagulant ("wet-splitting")
  - Forces formation and alignment of streams of negatively charged 2D sheets in parallel
  - Coagulant initiates ionic cross-linking as cations diffuse into the gel's inner structure and undergo electrostatic attraction.

- 3. Retrieving fibers and hanging to air-dry


2.2.1. Parameters to determine

- Coagulating cation (Ca²⁺, Fe³⁺, Na⁺, Ni²⁺): Balance between conductivity and mechanical strength.
- Coagulation bath solvent: Water by hydrogen bonding is key to maintaining a fibrous shape while also achieving high conductivity, we mix GO with HT-MoS₂.

2.2.2. GO Fibers

- GO fibers for flexible energy storage: A bit of a stretch?

2.3. Electrical Properties

- Higher conductivity is observed in HT-MoS₂, likely due to the rich hydrogen functionality on the surface.

3. Conclusion & Next steps

- • GO/1T MoS₂ fibers were successfully fabricated by wet-spinning.
- • Fibers with hydrothermally synthesized 1T-MoS₂ nanosheets show higher conductivity, making them a promising option for flexible battery anodes.

Future plan:
- • Improve HT-MoS₂ yield (currently 28% success rate due to sensitivity of MoS₂ phase transformations to temperature and pH).*
- • Stock GO gel used was two years old, which can lead to partial reductions in the material, contributing to increased conductivity but lower mechanical strength.*
- • Synthesize fresh batch of GO to investigate balance between conductivity and mechanical strength.

References