



SEM images of  $\text{Cu}_2\text{Mo}_6\text{S}_8$  and acid leached  $\text{Mo}_6\text{S}_8$  obtained by precursor route

## Chevrel-Phase Cathodes for Rechargeable Magnesium Batteries

### Opportunity

Advancing rechargeable magnesium batteries depends on cathode materials that can accommodate multivalent  $\text{Mg}^{2+}$  insertion without structural collapse while also being produced through practical, scalable synthesis routes. Conventional preparation of Chevrel-phase  $\text{Mo}_6\text{Z}_8$  compounds often requires sealed ampoules, extended heat treatments and handling of reactive precursors, creating safety concerns and limiting throughput. To address these constraints, researchers at the U.S. Department of Energy's National Energy Technology Laboratory (NETL) and the University of Pittsburgh (Pitt.), developed a precursor-driven synthesis that forms Chevrel-phase structures through controlled thermal conversion of mixed metal compounds rather than sealed-vessel reactions. This route enables more uniform stoichiometry, reduces processing time and improves phase purity. The resulting materials exhibit stable and reversible magnesium intercalation and can be integrated with compatible electrolytes to assemble robust cells for high-capacity energy storage. This technology is available for licensing and/or further collaborative research from NETL in partnership with Pitt.

### Problems Addressed

- Conventional Chevrel-phase synthesis requires long high-temperature processing in sealed ampoules, leading to high cost, sulfur vapor hazards and non-stoichiometric products.
- Many precursor routes require hydrogen atmospheres or extended chemical leaching, limiting scalability.
- Magnesium battery development is hindered by electrolytes that block  $\text{Mg}^{2+}$  transport.
- Existing cathode materials may not support reversible intercalation of divalent ions such as  $\text{Mg}^{2+}$ .

### Potential Commercial Application

- Rechargeable magnesium batteries using Chevrel-phase cathodes.
- Electrochemical cells incorporating cathodes derived from precursor-based synthesis routes.
- Energy storage systems requiring solid cathodes with reversible metal-ion intercalation.

### Competitive Advantages

- Precursor-based synthesis enables direct, scalable formation of  $\text{M}_x\text{Mo}_6\text{Z}_8$  and  $\text{Mo}_6\text{Z}_8$  Chevrel-phase materials.
- Chevrel-phase structures support reversible  $\text{Mg}^{2+}$  intercalation at room temperature.
- High-energy mechanical milling and precursor mixing reduce synthesis time relative to prolonged solid-state or ampoule-based methods.

### Intellectual Property Status

A U.S. patent (US9947962) was issued on April 17, 2018, and expires on May 18, 2036.

### Publications

P. Kumta, et al. Cathodes and electrolytes for rechargeable magnesium batteries and methods of manufacture. (2018). United States Patent and Trademark Office. U.S. Patent No. 9,947,962.

### Licensing

Partnerships@netl.doe.gov

### Inventors

Prashant Kumta, Partha Saha, Moni Kanchan Datta and Ayyakkannu Manivannan

