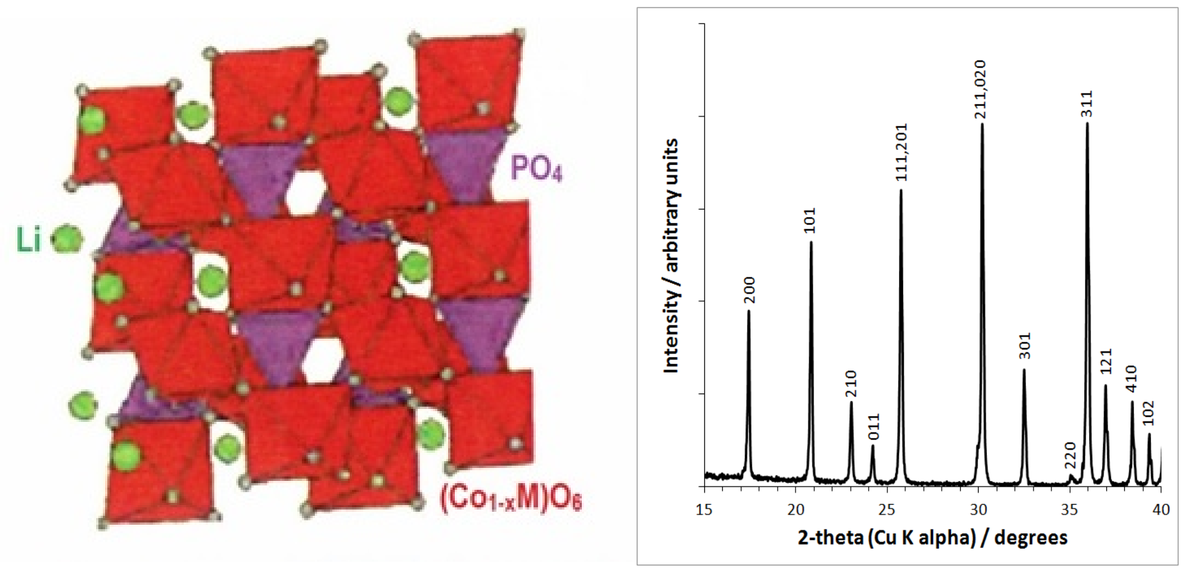
Energy Storage Materials

S&T Campaign: Materials Research
Energy & Power
Energy Storage

Dr. Jan L. Allen
(301) 394-0291
jan.l.allen8.civ@mail.mil

Research Objective

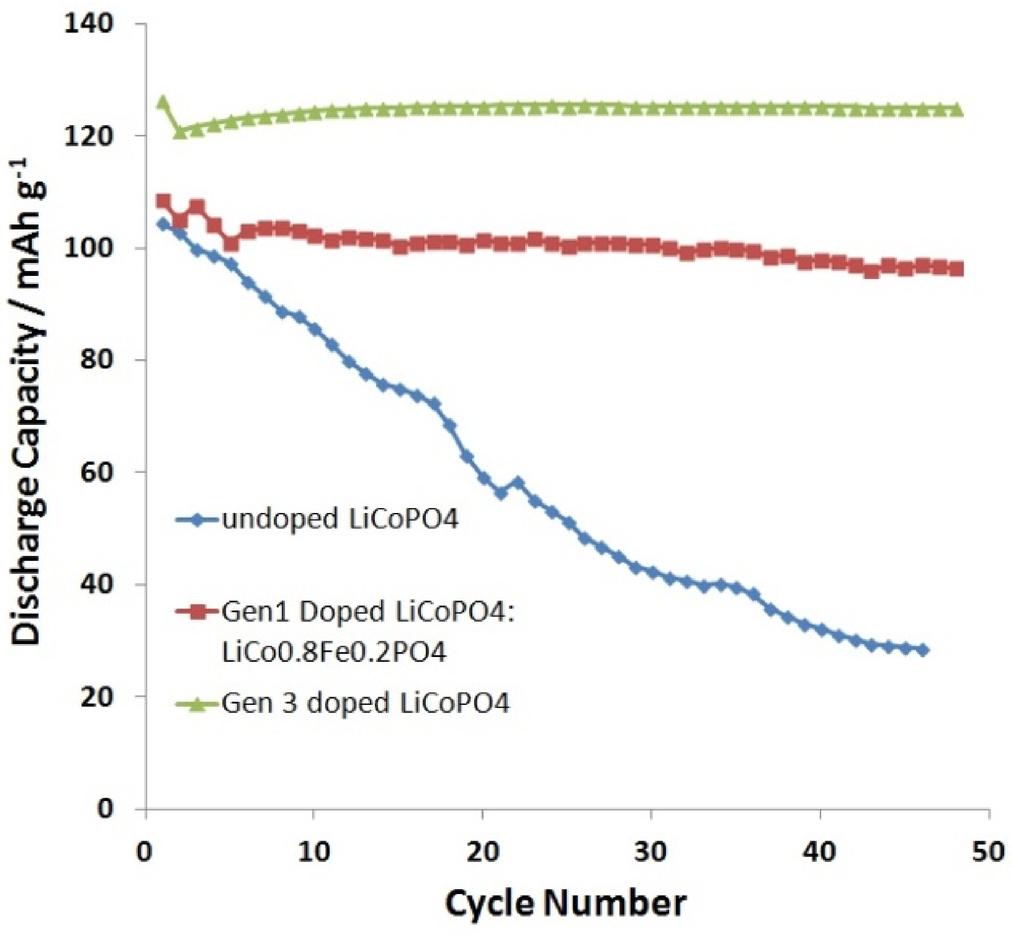
- **To develop & understand the basic science of safer, higher energy batteries that operate in all military environments**
- **Study & develop 5 V Li-ion cathodes and anodes, beyond Li-ion batteries, and supporting electrolytes**



$LiCoPO_4$ crystal structure and X-ray diffraction plot

Challenges

- **Electrolyte and electrode materials stable at 5 V and working at temperature extremes**
- **Scale-up of materials from the laboratory scale to the production scale**
- **Electrolytes for Li anodes and beyond Li-ion**

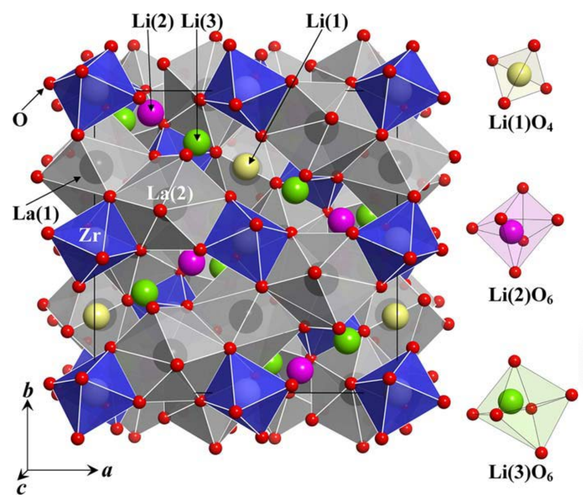


Cycle life and capacity improvements to $LiCoPO_4$ made by ARL.

***AFM - atomic force microscopy**
SEM - scanning electron microscopy
FT-IR - fourier-transform IR spectroscopy
DSC - differential scanning calorimetry
TGA - thermal gravimetric analysis
XPS - X-ray photoelectron spectroscopy

ARL Facilities and Capabilities Available to Support Collaborative Research

- **ARL-led Center for Research in Extreme Batteries**
- **Dry room, glove boxes, coating equipment for prototyping batteries, ballistic abuse testing**
- **0Electrochemical instrumentation for impedance, capacity, voltammetry measurements**
- **In situ electrochemical AFM* and X-ray diffraction, SEM, Raman, FT-IR, DSC, TGA, XPS**
- **US Patents 9,356,291, 9,114,779 in high voltage cathode materials**
- **Unique $LiCoPO_4$ based electrode, unique electrolyte additives, Li-ion electrolyte & electrode expertise**

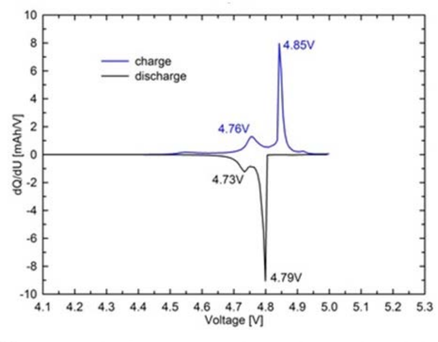


Structure of $Li_7La_3Zr_2O_{12}$ solid state electrolyte under development at ARL

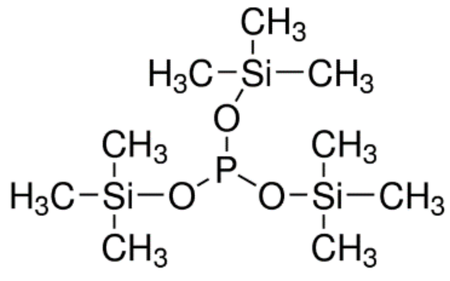
Prototype cell for ARL high voltage electrode

Complementary Expertise / Facilities / Capabilities Sought in Collaboration

- **3-D solid ceramic printing / fabrication capability**
- **Synchrotron x-ray and neutron sources for diffraction**
- **Solid state nuclear magnetic resonance unique spectroscopic techniques**
- **Suggestions for innovative new research approaches to address research objectives**
- **Promising electrode, electrolyte & coating materials & techniques for high voltage Li-ion**



Differential capacity Gen3 $LiCoPO_4$



Electrolyte additive