Summary of Lead Battery Science Research Program

Problem Definition

Although much empirical knowledge of battery operation has been accumulated, little is known of the formation processes of the reactant crystals and their dissolution. Given that lead batteries have been in use for over 150 years, this highlights the significant untapped potential for increasing lead battery performance through this project.

Objective

The objective of the Lead Battery Research Working Group is to understand and document the effects of various crystal morphologies of compounds contained within a lead battery on charge and discharge performance. This will include investigating which morphologies support optimum battery charge and discharge performance, and what effects additives (including carbon) and contaminants have on these morphologies. This knowledge is critical to improving both the performance and the life of lead batteries.

The study will be conducted at the Argonne National Laboratory (ANL) in Chicago using high intensity X-rays generated by the synchrotron (APS-advanced photon source) to study the reactions in *real time*, something not previously done with lead batteries.

Work Plan

Divided into 3 phases:

Phase 1: To investigate the dissolution, nucleation and growth kinetics of different crystallographic planes of lead sulfate crystals, determining the morphologies preferred for enhanced performance and extended battery life.

Phase 2: Investigate the 'real-time' operation of negative electrodes, with and without the addition of a proven concentration of carbon addition, employing ex-situ and in-situ electrochemical and basic material science techniques. Future work could investigate different carbon types and concentrations, and the role of nano-carbons when added to the PAM.

Phase 3: Understand the impact of varying electrolyte concentration on battery performance, using μ-analysis techniques within the electrode pores to investigate any differences in the precipitation and dissolution mechanisms of lead, lead dioxide and lead sulphate crystals in both the PAM and NAM as electrolyte concentration and temperature are varied.