An Investigation of High Capacity Lithium-ion Battery Anodes

Weldegabriel, Ezra (School: Mayo High School)
Hill, Erik (School: Century High School)
Kocer, Ardashir (School: Century High School)

Traditional Lithium-Ion Batteries (LIBs) feature suboptimal graphite anodes with low cost efficiencies and poor energy densities compared to modern high-capacity anodes (HCAs). However, despite their theoretical superiority, HCAs have yet to be implemented due to their volumetric expansions and contractions of up to 500% when lithiated and delithiated. Therefore, we made aluminium HCAs porous on a microscopic scale such that these novel anodes will expand into themselves, thus circumventing their traditional consequences. We synthesized a silica based aluminum xerogel sintered at 600°C to minimize electrical resistivity, and slowly saturated it with a battery electrolyte solution. We then tested the xerogel's performance as an HCA by placing it in a LIB alongside a commercial cathode and repeatedly charging, discharging, and cycling the battery. The HCA created by our method has a greater theoretical energy density when compared to commercial batteries; further, it is possible to drastically reduce the environmental impact of LIBs by using this method in conjunction with a conservationist model of LIBs, wherein HCAs can be made replaceable which may lead to an immense amount of lithium conserved which could lead to a reduction in harmful mining practices and a significant improvement in cost efficiency. The increased energy density enables a reduction in dependency on fossil fuels by making less reliable sources like wind more viable