Aluminum, Batteries, and Carbon

Zhao, Jacob (School: Bend Science Station)

Aluminum-ion batteries, with a stainless steel mesh cathode, aluminum (Al) anode, and salt(NaCl) water electrolyte has the ability to sequester CO2 around it, generating aluminum oxalate as a byproduct. It can also be recharged up to 7,500 times without capacity loss, about 750% more than that of the standard lithium-ion battery(Tarantola, 2016). However, the battery sequesters CO2 very slowly. I wondered, if I changed the cathode and the electrolyte, would the battery sequester CO2 more efficiently? I selected two different metals (copper (Cu) and stainless steel) and a powder (carbon (C)) to act as potential cathodes, along with three different salt solutions (NaCl, CaCl2, and NH4Cl) to act as electrolytes. The anode remained as aluminum. To test CO2 absorption rate, I built all nine battery variants, and placed them, along with a control (no battery), into separate air-tight containers. CO2 was pumped into the chambers, and CO2 levels were monitored for 24 hours, after which batteries were shifted to a different container, and the experiment was repeated four more times. Data collected showed that chambers that contained batteries had, on average, a faster rate of CO2-level decline. Batteries with a copper or carbon cathode and NaCl water electrolyte sequestered CO2 at a significantly higher rate than an average CO2-level rate of decline (control). Batteries with a stainless steel cathode and NaCl electrolyte also sequestered CO2, but not by a significant margin from the control. Data collection on the other electrolytes is uncompleted, but preliminary data shows a similar trend to this data. In conclusion, this experiment determined that aluminum-ion batteries with copper or carbon cathodes sequester CO2 efficiently, and batteries with stainless steel do not.