Research Plan

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Controlling The Pathways To The Synthesis Of A New Lithium Manganate

Chemistry

a) Rationale:

Global fossil fuel usage is the largest contributor to anthropogenic climate change. Lithium-ion batteries provide a high efficiency energy source that can replace fossil fuels and mitigate climate change. Their rechargeability, high power, and low weight make these batteries more efficient than previous energy sources. Lithium manganates are potential anode materials for such batteries. The lithium manganate crystals produced in this project were low cost and used abundant reactants like Li_2CO_3, Li_2O, MnO, and LiCl. The growth of the crystals did not require the use of expensive equipment or machinery. The ability to make cheap lithium-ion batteries is essential in order for renewable energy to become cheaper than fossil fuels.

b)

Research Question:

What are the ideal growth conditions to produce the most successful lithium manganate crystals?

Hypothesis:

The purity of the $LiMnO_2$ sample has an effect on the success rate of the growth of the lithium manganate crystals. The temperature the $LiMnO_2$ sample is taken out of the furnace and the amount of water in the $LiMnO_2$ sample affect its purity.

c)

Procedure:

Making $LiMnO_2$:

1. Measure 0.318 g of Mn_2O_3 and 0.6812 g of Li_2CO_3
2. Combine the Mn_2O_3 and Li_2CO_3 and press them into a pellet using a die press
3. Place the pellet in a quartz tube that is cushioned with quartz wool and seal the tube using a torch

4. Place the quartz tube in a furnace at room temperature
5. Set the furnace to heat up to 900C before cooling back down to room temperature
6. Break open the quartz tube using a hammer and retrieve the LiMnO2 pellet

Making Li2MnO3:

1. Measure 0.1277 g of LiMnO2, 0.0745 g of Li2O, and 0.7978 g of LiCl
2. Combine the reactants in a 7cm long silver tube. Seal the tube using a torch
3. Place the silver tube into a furnace at 200C
4. Set the furnace to heat up to 900C and slowly cool down to 600C
5. Remove the sample after 60 hours and use a pipe cutter to remove the Li2MnO3 crystals

Risk and Safety:

1. Use goggles and an apron when measuring out the reactants
2. Turn on the hume food when measuring out the Li2O and the LiCl
3. Use oven mitts when opening and closing the furnace
4. Wear goggles and a fire-proof apron when using the torch

Data Analysis:

X-ray powder diffraction, x-ray single crystal diffraction, and UV-vis will be used to analyze the samples. UV-vis will be used to compare the absorbance of each sample to see how the different variables changed affected absorbance. X-ray powder diffraction will be used to determine the purity of each LiMnO2 sample and find potential impurities. X-ray single crystal diffraction will used to determine the purity of the Li2MnO3 single crystals and find potential impurities. The Pearson's crystal database will be used to identify the name of the impurities from the lattice parameter data provided by the x-ray diffraction.

d) Bibliography:

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