Framework Outline - Team Lithium

Ivette Morales
Alexander Alvarado
Kelsey Lawson
Derek Chang
Jacob Orozco

Lithium-Ion Battery for Small Electronics

- Introduction - all
    - When Developed
        - The first battery was developed by Alexander Volta in the year 1800 using copper and zinc disks separated by cloth in a briney solution of salt. (history)
    - State of the art
        - The lithium ion is currently the state of the art for it minimizes weight needed while maximizing charge produced (specific energy + general info).
    - Significance
        - Utility to public
            - Provides many uses in regards to handheld devices, electric vehicles, etc.
        - Market share / Market Size
            - According to the report, the global lithium-ion battery market was pegged at $30.19 billion in 2017 and is expected to garner $100.43 billion by 2025, registering a CAGR of 17.1% from 2018 to 2025.
    - Leaders in the field
        - Panasonic
        - Samsung
        - Tesla
        - Toshiba
- Manufacturing Process
    - Ores/Mining - Jacob
        - Material
            - It is mined from ores of petalite ($LiAl(Si_2O_5)_2$, lepidolite $K(Li,Al)_3(Al,Si,Rb)_4O_{10}(F,OH)_2$, spodumene $LiAl(SiO_3)_2$ and also subsurface brines. (What ores Li comes from)
            - Cobalt mined in Dominican Republic (and more)
        - Labor

            - Most common labor for mining is done in South America.
            - Alternative method: a nano-filtration system that uses a set of highly specialized membranes to passively sift lithium from wastewater. (Filtration)
            - Cobalt mining in Congo (Labor)
        - Energy
            - Uses water and heating to make petalite form into lithium carbonate (How to form lithium carbonate)
    - Processing to get Li pure enough for battery processing - Kelsey
        - Material
            - Lithium carbonate that is processed into just Lithium (How Li is Processed)
        - Labor
            - Lithium carbonate has to undergo extraction usually through a brine = period can be from several months to a few years (Extraction)
        - Energy
            - The brining process uses an estimated 500,000 gallons of water & is then sent over to processing plants by fossil fuel methods (Energy)
    - How the actual battery is made - Derek
        - Material
            - Most common: Lithium cobalt oxide (cathode) & graphite (anode) = used for portable electronic devices (Overview of Li Battery)
        - Labor
            - The cost of a lithium battery is calculated by $/KWh and typically for smartphones the battery cost is $2 - $4, while in an electrical vehicle it can cost from $7,000 - $20,000. The processing and manufacturing usually accounts for 35% of the cost. (Labor)
        - pros/cons
            - Pros
                - Lithium batteries have a much higher energy density than other batteries. (Cost)
            - Cons
                - Lithium-ion batteries are also more expensive to produce, as they can cost nearly 40% more to produce than nickel-cadmium batteries. (Cost)
    - Production line - Alex
        - Material

        - Cathode contains Lithium compounds and binder
            - Mixing → Coating → Compressing → Drying → Slitting
        - Anode contains carbon (graphite) and binder
            - Mixing → Coating → Compressing → Drying → Slitting
        - Nickel Plating
    - Labor
        - Autonomous Labor -- Cell assembly is mostly highly automated work
            - PCB Spot Welding
            - Quality Control
                - Battery testing
            - PCB Nickel Plating welding
        - Manual Labor
            - Inserting insulator paste
            - Lower Sheel Capping
            - Battery pole spot welding
    - Pros/cons
        - Pros
            - Highly Automated factories are able to mass produce the battery components cost efficiently
        - Cons
            - Contamination, physical damage, and burns on the electrodes are particularly dangerous since they can cause short circuits
- Factory - findings from companies - Ivette
    - A company Details
        - Samsung is one of the leading companies in the market. They are an ODM/OEM company meaning that design and fabricate their products thus cutting down on energy production and labor. They are currently transitioning to an energy storage system in which the company is planning to be more sustainable in terms of energy consumption.
        - Panasonic -- can't find much on production
        - Toshiba has their production line in China where the production and labor costs are low, however that does not mean that they are more energy conservative.
        - Tesla and Panasonic are working together to build the Gigafactory, where other electrical battery producers are able to produce Li-ion batteries more energy efficient.

- Analysis
    - Pros - Alex
        - Essential in modern-day electronics
    - Issues - Ivette
        - Lithium is a scarce material, it is not necessarily the most sustainable material that is being sourced.
        - It is not the cheapest material to be mined and processed.
        - The production of Li-ion batteries takes 29 GJ to produce and 58GJ of user consumption.
            - Cobalt is the most critical material, in terms of scarcity.
- Recommendations
    - Opportunities for improvement - Kelsey
        - Solid-state; extraction & recycling process = looking at other ways to mine Li & need more intuitive ways to have people recycle old Li batteries (Extraction)
    - Other materials/alternatives to be used - Jacob
        - Lithium-Sulfur, Aluminum Graphite, Bioelectrochemical, Solid-State batteries
- References
    - https://www.sciencedirect.com/science/article/pii/S1364032118300728?via%3Dihub#s0060 (in general lithium battery things)
    - *Lithium Battery Manufacturing*, www.mpoweruk.com/battery_manufacturing.htm.
- Acknowledgments
    - For future companies who helped us along the way from interviews, etc.