THE BATTERY CHRONICLES

STREAMS
SUSTAINABLE TECHNOLOGIES FOR REDUCING EUROPE'S BATTERY RAW MATERIALS DEPENDANCE

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Türkiye's Battery Sector

In parallel with Türkiye's geographical position, – the bridging between Europe and Asia-, the technological developments have immensely effected and evolved by the advancements in both sides. Battery sector in Türkiye has been still in the development phase but it is obvious that a huge potential lies here. Recently, Türkiye has attracted many investments from China's electric car companies. The local battery cell companies are also increasing by number. In the look of a researcher, I wish that investments will further ignite the improvement in battery materials and cell production sector as well.

How collaboration across projects or between academia and industry could help address some of these challenges

In the Energy Storage Systems Division in Tübitak, as a result of being the main research Centre of Türkiye, it is very fortunate to have a variety of partners and customers all over Türkiye. That helps us to observe the problems of starts-up faced in the production of battery materials and the drawbacks experienced in universities to make their research commercialized, and help them to overcome such challenges. Scaling up any new type of cathode and anode materials requires special attention as each type of material show different surface properties, particle morphology, chemical composition, impurities and so on. Generally, the initial step for scale-up would be meticulous characterization of active materials and identification of their properties. Subsequently, the formulation of slurries surely varies with respect to material properties.

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There are also limitations in terms of equipment used and the laboratory environment that slurries prepared specific to materials. In order to have an insight on battery application of the materials, the coin cell level electrochemical tests would give an initial idea. Additionally, the information obtained in coil cells needs to be verified by bigger cell formats such as pouch cell. Another challenge arises from this process. The larger amount of materials in a slurry introduces extra intermolecular forces between particles that can lead to heat generation during processing or lead failure in obtaining the required viscosity. That also has a direct effect on electrode quality and the cells produced from these electrodes. So, the needs of industry in terms of solving such scientific problems come up during processing and the desire for commercialization in university based research might match up and help boosting the improvements in batteries.

Developments in Electrode Manufacturing

As many challenges are identified in these processes, many new approaches are being investigated. In the equipment level, new type of slurry mixers such as hydrodynamic shear mixers, ball-mill mixers, and ultrasonic mixers or conventional planetary mixers equipped with special propellers provide advantages such as improvements in mixing time, energy efficiency, and decrease in bubble generation inside slurries. A degassing step and sieving of slurry after slurry prepared have been found as effective steps considering the subsequent quality of electrodes. The minimization of moisture in each step of manufacturing has also a great impact on long-term cell performance. Preparation of high quality electrodes has great importance in the cell performance as well as in the safety of the cells. For that purpose, flawless electrode lamination, homogenous coating on current collectors and high coat-weight uniformity are also major targets to be achieved. For that purpose, the type of the coating method and equipment used are also evolving with research. The automation of electrode and cell production as well as the integration of quality control mechanism in each step of this processes are some other areas of research on the way to manufacture reproducible high quality electrodes and cells.

Sustainability of Electrode and Cell Manufacturing Processes

For a cleaner and sustainable production process, one of the main challenges is to replace the hazardous chemicals in wet electrode processing with non-hazardous options or find solvent free processing options. The extrusion of dry powders and applying the mixture on current collectors under high pressure provide thick electrodes, however, this process still needs to be improved in terms of inhomogeneous dispersion, lack of compatible binders for such processes and increased impedance in the produced electrodes. Utilization of dry coating would also eliminate drying process of solvents after lamination.

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Using aqueous processing in the production of electrodes as in STREAMS project, the hazardous chemicals are avoided and replaced by a safer alternative. Although, the higher surface tension of water compared to NMP solvent leads to less wettability in the lamination process of water based slurries, this process has already been adopted by industry on anode side. As a result of more sensitive and reactive nature of cathode materials with water (especially at higher Ni content) and Li-leaching problems, it is still a challenge on the cathode side. To overcome that issue, special binders and additive compositions need to be formulized. Some other challenges with aqueous processing, is more residual water presence in electrodes after primary drying step compared to NMP based processing due to the hydrophilic nature of binders, crack formation, and the corrosion of aluminum current collectors.

In STREAMS, high quality electrodes from recycled/recovered anodes and cathodes with aqueous processing will be obtained, and 10 Ah cells will be prepared from these electrodes. The technical objectives in cell level are set as 1000 cycles to 80% SoH for NMC//graphite and 500 cycles to 80% SoH for NMC//Si-Graphite at symmetric 1C discharge and 1C charge rates. In order to match these objectives, Tübitak will closely work with AIT and the discussions within this article will be deeply considered.

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