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Electric Batteries: Present Problems and Future Prospects

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Nowadays, electric vehicles (EVs) are vivid symbols of the transformation towards a sustainability and eco-friendly society. Global warming which is caused by global greenhouse gas (GHG) emissions became a significant challenge over the last several decades, causing a number of different problems, most of which pertain to the quality of air. Due to increasingly poor air quality in huge cities around the whole world, various developed countries have begun to set out plans to phase out or completely ban the production and use of combustion-only vehicles. So that's why EVs are spreading rapidly and many countries are promoting the production and use of hybrid or fully EVs.

As previously mentioned, poor air quality in large cities is the main reason for pushing countries towards the phasing out or complete ban of combustion engine vehicles. This is being done with the hopes and expectations that the transition to hybrid electric vehicles (HEVs) and EVs will mitigate and decrease GHG emissions into the atmosphere and improve the overall air quality in the whole world. Countries such as Germany, Norway, the Netherlands and India have all claimed that they plan to ban the sale of combustion engine vehicles within the next 12 years. Currently, only 0.2% of the vehicles driving on the streets globally are EVs, which correlates to a value of approximately 2 million EVs. However, this figure is expected to increase drastically with the implementation of the combustion engine ban in the following years. Figure 1

represents a forecast of predicted car sales numbers, comparing combustion engines, EVs and HEVs in the upcoming years. According to Figure 1, both EVs and HEVs sales are expected to increase by 2030 while combustion engines are predicted to drop by roughly 10 million units sold. Therefore, the demand for car batteries is considered to be increasing in the near future. As the result, an increasing amount of lithium-ion batteries (LIBs) will reach the end of their usable life and will require effective and sustainable end-of-life management plan which includes recycling.

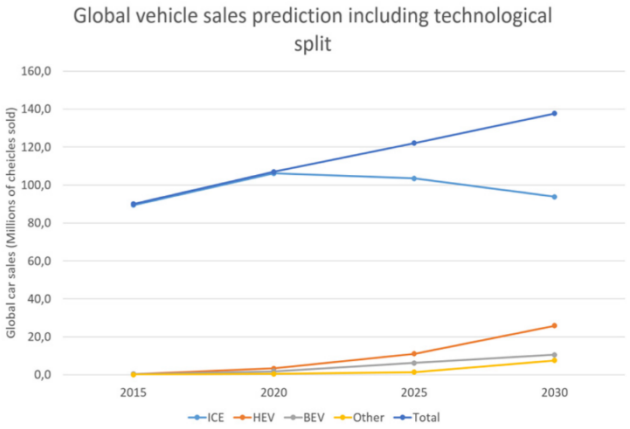

Figure1: Forecast of the Predicted Car Sale by 2030

The main components of the LIB are the anode, the cathode, the electrolyte and the separator. Figure 2 shows the construction of a typical cylindrical cell and a typical pouch cell. Such cells provide a relatively light and small source of energy and are now manufactured in very large quantities (>1 billion cells per year). In an automotive application a LIB

consists of tens to thousands of individual cells packaged together to provide the required voltage, power and energy [1].

Figure 2: Lithium-Ion Battery Composition

The variety of the types of anodes used in LIBs is extremely subdued due to the market dominance of graphite. The latter was first commercialized 20 years ago and due to its high natural abundance, low cost, and moderate energy density it quickly became the primary anode material in LIBs [2]. Although graphite remains wide-scale used material commercially available for battery anodes, an alternate material lithium-titanium oxide has captured recent attention.

The cathode is considered to be one of the most selective materials during LIB development. The main categories of cathodes are energy density, power density, cost and lifetime.
The separator in an LIB is used to encapsulate the electrolyte inside the battery itself [2]. It is a crucial LIB component, as it must facilitate ionic conductivity while preventing direct contact between the anode and the cathode, in other words, it is a physical barrier between the anode and the cathode.

Cost. Further improvements of battery capacity and their costs reduction are essential for the broader acceptance and use of EVs. Over the last decade, batteries have already been substantially improved, but further cost reductions are

necessary to increase competiveness of electric cars on the future automobile market.

Reuse & Recycling. A significant strategy and potential flow to reduce the cost, impacts on the environment is to integrate the use of remanufactured vehicle batteries over the use of new ones. This can cut cost because most cells in the battery are often still fully operational, and only a few cells need to be remanufactured for the battery to function at the required capacity. As with the reuse of the EV battery, effective recycling methods have the potential to reduce the environmental impact significantly. In fact, LIBs have many valuable metals which make recycling the battery a cost-efficient option, the raw material value of 1 ton of batteries is valued at around $7,708.

To sum up, the drastic growth of EVs and LIBs, therefore will become a highly valued industry which is currently has many areas for improvement. The current designs of LIBs implemented in EVs are not sufficient to be competitive with traditional combustion vehicles, and further development of the batteries should facilitate long term growth in the market. Consequently, the modern batteries will undergo drastic changes in material properties that will increase their performance in the future.

References:

1. Automotive Lithium-Ion Batteries State of the Art and Future Developments in Lithium-Ion Battery Packs for Passenger Car Applications [Electronic resource]. – Mode of access: http://www.dx.doi.org. - Date of access: 13.12.2019.
2. Lithium-Ion Car Batteries: Present Analysis and Future Predictions [Electronic resource]. – Mode of access: http://www.eeer.org. - Date of access: 13.03.2020.