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The Solid Frontier – The Future of Solid State Batteries in the Automotive Industry

Elizaveta Buch[1], Tea Pajan[1], Andreas Hintennach[1], Claudia Bucharsky[2], Günter Schell[2], Michael J. Hoffmann[2]

[1]*Daimler AG, Wilhelm-Runge-Strasse 11, 89081 Ulm, elizaveta.buch@daimler.com*

[2]*KIT, Haid-und-Neu Strasse 7, 76131 Karlsruhe*

Summary

All solid state batteries offer some improvements compared to common Li-ion batteries but have also some challenges. This poster presents some promising materials in solid state batteries and give an overview about application in the automotive industry.

Keywords: Battery, Solid State

1 Introduction

The challenging process of vehicle electrification requires continuous improvement of current battery technologies. For example, most batteries used in mobile devices or power tools are based on Li-ion chemistry [1]. Such systems offer high power and high energy density, and are therefore also used in full electric vehicles, plug-in hybrids and full hybrids. However, the liquid electrolytes in common Li-ion batteries are flammable and can leak in case of mechanical damage. The interface reaction between the electrolyte and the electrodes may lead to dendrite formation and, consequently, cause a thermal runaway [2].

Problems like electrolyte leakage or flammability could be avoided by switching to all solid state batteries. This type of battery is characterized by a solid, non-flammable electrolyte as well as a long lifetime and high cycle stability.

In contrast to liquid-based electrolytes, which imply single cell packaging, all solid state batteries offer more compact cell formats. Furthermore solid state batteries do not require a separator. Figure 1 shows a solid state cell (left) and cell stack (right).

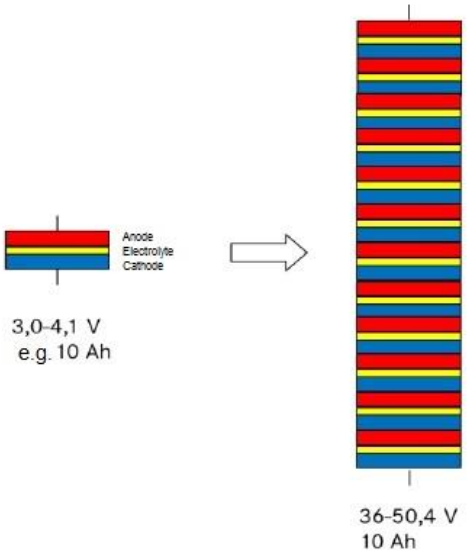

Figure1: Solid state cell allows closer stacking

However, there are also some challenges, like low conductivity at ambient temperature, higher production costs compared to common Li-ion technologies, and low interface between electrodes and the electrolyte surface. This poster will show some strategies to overcome these obstacles [3].

Solid state electrolytes can be categorized by material classes like polymers, glasses or ceramics, which can additionally be classified in bulk materials and thin films.

2 Battery requirements

There are some requirements for automotive battery applications:

- capacity,
- power,
- safety,
- fast charge,
- sustainability
- cost.

The importance of each point depends on the driver profile: E.g. a taxi driver has other requirements than commuters or housewives, in the north you may have to heat the battery, in the south you may have to cool it. So it is possible that the same materials reach different levels of this requirements. Due to this it can be useful to offer batteries with different materials depending on driver profile.

Furthermore this points depend on each other and contains further variables. The success of single materials can be seen just in the context of a whole battery system which includes e.g. cooling or heating of the battery, sensors, necessary shell.

3 Examples of Materials

There are also requirements on materials for solid state batteries:

- Nontoxic
- Cost
- Available (physically and politically)
- Easy handling while production

Figure 2 shows some raw materials where supply risk is plotted against economic importance.

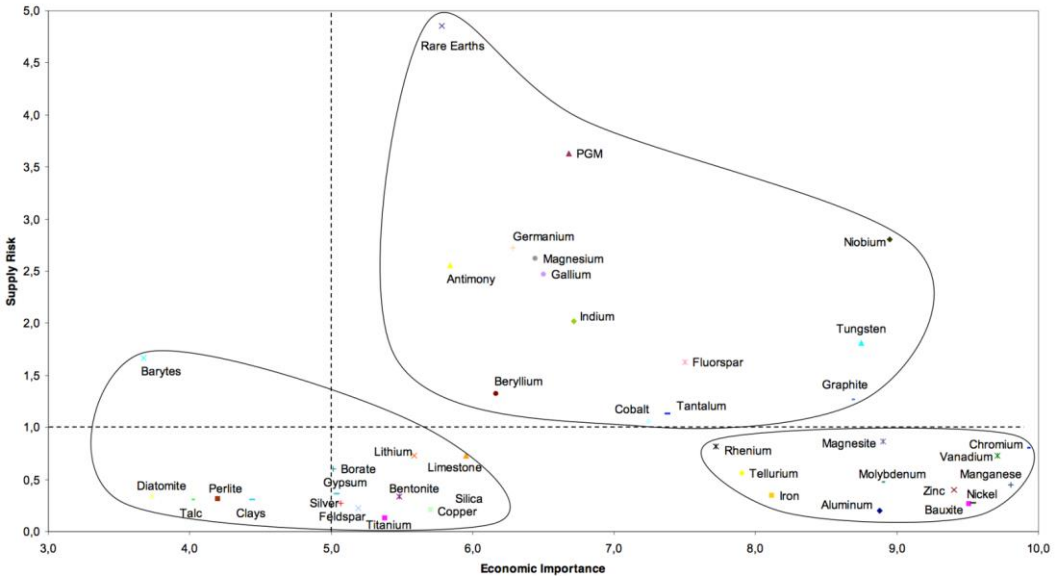

Figure 2: Comparison of Raw Materials [4]

In my poster I will take a closer look at the most common and promising materials [5] and give an outlook to future applications of solid state batteries in the automotive industry.

References

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Authors

Elizaveta Buch is a first-year PhD student at Daimler AG in Ulm. She received her Master's degree in Experimental Solid State Physics from Goethe University Frankfurt, which is also where she completed her Bachelor's degree. At the moment, Elizaveta is working in the electrochemical laboratory in Ulm at Daimler AG, where she does research on Solid State Battery Materials.