

## ZIM-project MgBatteryHousing:

### Development of a flame-resistant magnesium battery housing for electric motorcycles and the associated value chain

#### Sub-project:

#### Development of a mixing process for granulate made of flame-retardant alloy with carbon additive

The ongoing development of electromobility affects all areas of transportation, including the motorcycle industry. In addition to performance and the ability to charge quickly, the driving range and therefore the weight of all components is a key factor for batteries. The use of magnesium as a lightweight material for battery housings is therefore very interesting. However, there is a risk of flammability in combination with lithium-ion batteries, which must be minimized. For this reason, NMF is part of a consortium developing a complete process chain for manufacturing battery housings using a new, flame-retardant alloy.

Within the scope of this project, the entire process chain for producing battery housings from a new, flame-retardant alloy is investigated. Special elements (e.g. Ca, Y) and very fine carbon powder ( $< 1 \mu\text{m}$ ) are added to achieve flame resistance and good properties at the same time. High shear forces are required to incorporate the powder. Therefore Thixomolding® is a suitable casting process. The entire production chain is to be developed: Melting and granulating the Mg alloy, mixing the granulate and C additives, implementing the mixing process in the casting process, optimizing the casting tool and casting process as well as characterizing the alloy. Another focus is on recycling.

### Value added chain

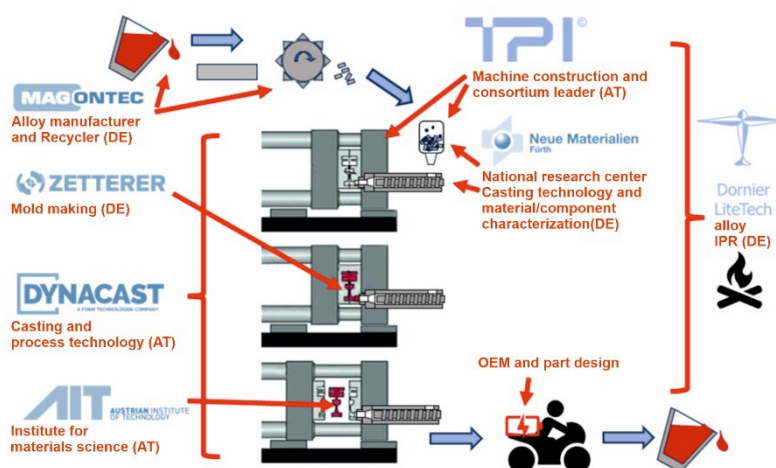


Figure 1: Overview of the entire value chain to be covered in the project

The first step in the process chain is the melting of the Mg alloy. As a basis the ideal chemical composition has to be determined. The alloy content must be optimized considering good flame retardancy with sufficient castability (e.g. low tendency to sticking in the casting mold) or the manganese content with regard to corrosion and manufacturing costs. The mechanical properties of the new alloy are examined and a material chart is created. The melting process is then adapted for larger melting quantities and the prototype of a chipping plant is developed and constructed.

A key element for processing the flame-retardant alloy is the development and construction of a mixing conveyor prototype system in the project. The aim is to achieve a homogeneous mixture of Mg granulate and carbon powder directly at the casting machine (Thixomolding®, TPI) and supplying it uniformly with a sufficient mass flow. Tests are carried out at NMF using Thixomolding® for optimizing the prototype mixing device.

The suitability of the new flame-retardant alloy is examined in the project for two complex battery housing components. Using several software packages, the filling behaviour of the new alloy is analyzed and the casting process is optimized. Preliminary tests with existing casting molds can provide findings for initial fabrication specifications (gate thickness, draft angles, temperature management, etc.), which are will be verified by fabricating the battery housing components. Finally, an optimization of the casting process for the flame-retardant alloy is carried out with regard to the requirements (e.g. tolerances, porosity).

A material chart is created as a basis for simulations carried out regarding e.g. mechanical design, service life and crash behaviour. The results are compared with component tests. Subsequent processing steps, such as mechanical machining of the components, will also be investigated. An important aspect is to identify special characteristics regarding the coating of the alloy. For evaluation purposes, as a first step cast plates are coated with various coating systems (powder coating, anodization) and rated regarding adhesive strength, corrosion, etc. The best coating system is selected for vehicle tests.

Finally, the consortium will evaluate the economic efficiency of the process chain, identify opportunities for optimization and provide a comparison of battery housings made from the new flame-retardant magnesium alloy and conventional die-cast aluminium. In addition to the economic efficiency, the sustainability of the process chain, i.e. energy and material savings and CO<sub>2</sub> savings, will also be considered.

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