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PRESS RELEASE

New technologies for the disassembly of electric vehicle batteries and motors

The "DeMoBat" research project came to an end in April. For this, twelve project partners developed concepts and applications for handling and reprocessing electric car components in a sustainable and economical manner. The aim here was to avoid valuable raw materials going to waste. The project was coordinated by Fraunhofer IPA, with funding provided by the Ministry of the Environment, Climate Protection and the Energy Sector Baden-Württemberg.

The European Parliament's decision to ban combustion engines from 2035 has ensured that the future direction of travel within the automotive industry is definitively heading towards electromobility. Today, we are already seeing more and more electric cars on the streets. However, due to the fact that battery systems only have an average service life of around ten years, the amount of used batteries is growing, and so are the challenges related to the remanufacturing and recycling of the electrical components. In addition, this year's automotive trade fair in Shanghai has shown that the transition to electric cars is also altering the landscape of the global car market and that German carmakers will not find it easy to maintain their reputations as leaders in this field.

"A decisive factor behind establishing a competitive edge is the availability and cost of raw materials required for batteries and electric motors," explains Professor Alexander Sauer, Director of Fraunhofer IPA and project lead, before adding: "It is, therefore, all the more important to avoid simply shredding old batteries that still contain valuable raw materials, as has frequently happened before now." However, the basic prerequisite for being able to reuse battery components is that they can be disassembled according to type.

Strengthening the German automotive industry

Since the end of 2019, a total of twelve research partners have been working on precisely this ambition as part of the "DeMoBat" project for the industrial disassembly of batteries and electric motors in the German federal state of Baden-Württemberg. The project partners developed new concepts and technologies with the aim of handling and reprocessing the electrical components in such a way that as little waste as possible was generated and to minimize the loss of raw materials. A research project of this kind is crucial, especially for Baden-Württemberg, which is highly dependent on its strong automotive industry. For this reason, the project was funded by the federal

DeMoBat

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state's own Ministry of the Environment. On April 25, the project partners presented their findings during the final meeting at Fraunhofer IPA.

Modeling and analysis of disassembly processes for circular value added

In order to achieve the primary project goals, a holistic approach was required. Specifically, the focus here was on generating greater sustainability in the area of electromobility, securing economically strategic raw materials, and strengthening Baden-Württemberg and Germany as business locations.

The project's first task was therefore to examine the legal framework. In addition, an analysis of the market potential and return quantities of electric vehicle batteries was performed. On this basis, the project partners derived potential business models and evaluated them. A newly developed life-cycle data management system was used to supplement this work, in addition to a cost analysis of disassembly and recycling networks up to the year 2050.

Design for disassembly

An important aspect with regard to industrial disassembly is that the batteries should be designed in such a way that allows them to be manually or robotically repaired and disassembled. One challenge in this context are the numerous different battery types used by various car brands in their range of models, as their construction is currently still ill-suited to recycling or alternative circular economy strategies. One result of the project is a recommendation for action for a recyclable design. The battery, which can be disassembled, was also built as a prototype and thoroughly examined.

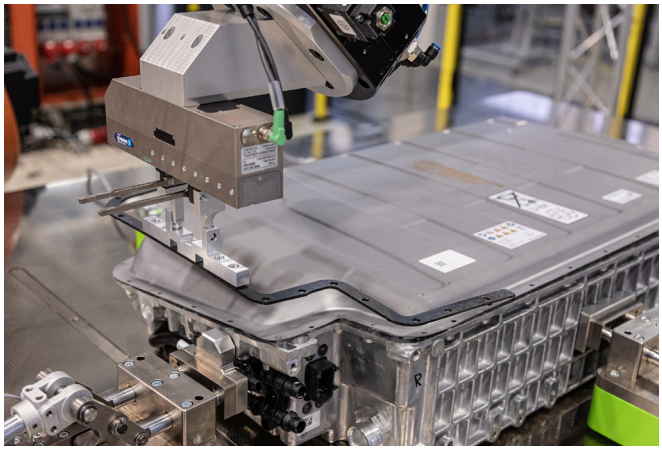
Battery capacity and handling

To begin with, the batteries must be tested for remaining capacity as well as any signs of ageing. Temperature analyses may also be carried out. After this come the handling tests, which demonstrate how the batteries can be opened up to facilitate the removal of the components. For this purpose, a robot-based demonstration platform was developed as part of the DeMoBat project. In addition, tools needed to, for example, grip objects and loosen screws and connections were also designed. For this, high-performance image processing is required that must be able to recognize a large number of screws and cables, among other items. However, over time, the components start to age and are therefore not always easily identifiable.

In total, 25 technologies were designed and tested in the project, eight of which were set up entirely as demo and test robot tools that were suited for use in continuous industrial operation. In addition, the project partners developed a flexible disassembly system that highlights non-destructive disassembly steps right down to cell level. The safety concept is an important part of the flexible disassembly system. Here, temperature is used as a possible indicator of a chain reaction in the event that a battery catches fire.

High pressure water jet facilitates reprocessing of chemical raw materials

The project partners also sought to establish an efficient value-added cycle. Initially, the aim was for this to work on the basis of mechanical separation and recycling of the components contained in the battery pack. The water-based recycling approach used is a new form of direct black matter recovery. In addition to a partially automated opening and separation of the cell components, a high-pressure water jet is used to remove the electrode coating from the carrier film. The efficiency gain is reflected by a Life Cycle Assessment (LCA) that shows a reduction in the greenhouse potential by a factor of 10 to 20. In this way, recyclates with a low CO_2 footprint can be supplied that, at high volumes, lead to a substantial reduction in greenhouse gas emissions generated by production activities.



The project developed a variety of hardware for automated disassembly tasks, such as this small parts gripper.
Source: Fraunhofer IPA/Photo: Rainer Bez

A tool dubbed "Knacker" was developed to prize apart the adhesive bonds between the upper and lower shell of a battery.
Source: Fraunhofer IPA/Photo: Rainer Bez

Automated disassembly of electric drive units

In addition, industrial robot technologies featuring specialized, self-constructed tools were developed. These helped to automate the disassembly process for electric drive units. Auxiliary image processing systems, which recognize screws and components and avoid having to manually teach the robots what to do in each individual process step, are also used for this. In order to prevent collisions between the robot and the components, sensors and 3D camera systems are used in a success check carried out once each disassembly process step is completed. A safe process sequence is ensured by way of subsequent signal transmission to the central process control.

Knowledge and technology transfer at a new test center

The technologies developed as part of the DeMoBat project form the basis upon which a new test center can be established. This is a place where new forms of battery production can be developed and tested in addition to activities focused on the further development of recycling electrical components. "The project therefore takes into account the essential technology transfer, which will allow Baden-Württemberg and Germany to assume the mantle of pioneers in the area of recycling electronic components," as Professor Kai Peter Birke, Head of the Center for Digitalized Battery Cell Manufacturing at Fraunhofer IPA, explains.

A total of twelve project partners from the fields of research and industry collaborated on the project.
Source: Fraunhofer IPA/Photo: Rainer Bez

During a tour of Fraunhofer IPA, the project partners had an opportunity to see the demonstrator for automated disassembly developed as part of the "DeMoBat" in action for themselves.
Source: Fraunhofer IPA

Outlook

Even after the successful conclusion of the "DeMoBat" project, Fraunhofer IPA is continuing to focus on projects in relation to sustainability and automated recycling processes. For example, in the "Desire4Electronics" project, researchers are seeking to develop solutions for the automated disassembly and subsequent reprocessing of small electronic devices. Conversely, the aim of the "ProDiREC" project is to enable more sustainable use of rare raw materials used in the manufacturing of lithium-ion batteries, while research into robot-led disassembly of future electrolysers is the focus of the "ReNaRe" initiative.

Project fact sheet

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