# THE CENTRE FOR RESEARCH AND TECHNOLOGY FOR RESOURCE-EFFICIENT LIGHTWEIGHT STRUCTURES OF ELECTRIC MOBILITY (FOREL)

M. Stegelmann, M. Müller and M. Gude

Institute of Lightweight Engineering and Polymer Technology (ILK), TU Dresden,
Holbeinstr. 3, 01307 Dresden, Germany
michael.stegelmann@tu-dresden.de, web page: http://tu-dresden.de/mw/ilk

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## Abstract

FOREL is a national, comprehensive platform for the development of lightweight system solutions for the electric mobility. It aims to use multi-material design methods for electric vehicles of the future. In order to identify important research areas for lightweight engineering and e-mobility, experts from various industries took part in a survey. The results were summarised in the FOREL study which presents existing approaches and potential developments. It reveals detailed insight into trends, including the growing importance of process combinations, lightweight design, hybrid joining technologies and adapted recycling strategies. The results suggest that future engineering will focus on fibre-reinforced plastic, light metals, high-strength steel and material adapted design [1]. Aside from highlighting many areas with potential, the study also highlights barriers to progress and areas requiring further research. The identified needs for developments e.g. in mixing different materials, as well as recycling concepts, are addressed by the eight coordinated FOREL research projects. All in all the cost neutral development of lightweight structures and manufacturing technologies is the most desirable turn out of FOREL.

## 1. Introduction

The National Electric Mobility Platform (NPE) identifies 'functionally integrative systematic lightweight construction in a multi-material design' as an important future technology to establish Germany as the top provider of e-mobility. As a national open cluster FOREL is helping to make this reality. By accelerating the path to industry, the platform will establish Germany as a world leading provider of lightweight components with its rapidly growing network [2].
The cluster was established in 2013 under the coordination of the Institute of Lightweight Engineering and Polymer Technology (ILK) of the Technische Universität Dresden. Supported by the German Federal Ministry for Education and Research (BMBF) and monitored by the Karlsruhe Project Management Agency (PTKA), FOREL brings together established German R&D centres with industrial leaders. By the end of 2015 FOREL has grown to a network of 65 partners being active in eight projects.
FOREL identifies needs for technology-orientated research, shows systemic research approaches and transfers solutions for lightweight engineering – that have been adapted for electric mobility – into industrial practice. Thus, several process chains are being developed, implemented and interlinked to a process network within a central technology centre.

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## 2. FOREL study

In order to analyse today's challenges and potentials in lightweight engineering 240 experts from different industrial sectors were asked about their opinion. The results of the survey were analysed and published in the FOREL study [1]. The questionnaire covered all relevant technological areas. A basic interest was to find out which type of materials will be used for manufacturing tomorrow's electric cars. The study revealed that there is de facto no single "lightweight material of the future." The trend towards the use of CFRP only represents a small portion of current developments. The experts expect a diverse mix of materials in the future, in which, besides reinforced and unreinforced materials, metals will also retain their place (Fig. 1).

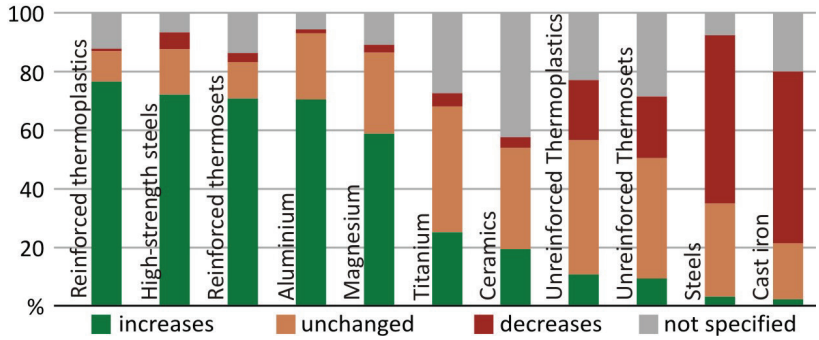


**Figure 1.** How industry experts estimate the material consumption of structurally-relevant lightweight construction parts for electric mobility within the next five years [1]

Taking account of these results raises further questions, e.g. how the increased material mix influences the general technological and economic properties of structural parts (Fig. 2). The surveyed experts acknowledge an improved flexibility and a general increase of the mechanical properties. On the other hand fundamental manufacturing steps like joining and forming are expected to become more difficult to realise. Additional costs and recycling were identified as main drawbacks and were therefore defined as core topics for the initiated FOREL research projects.

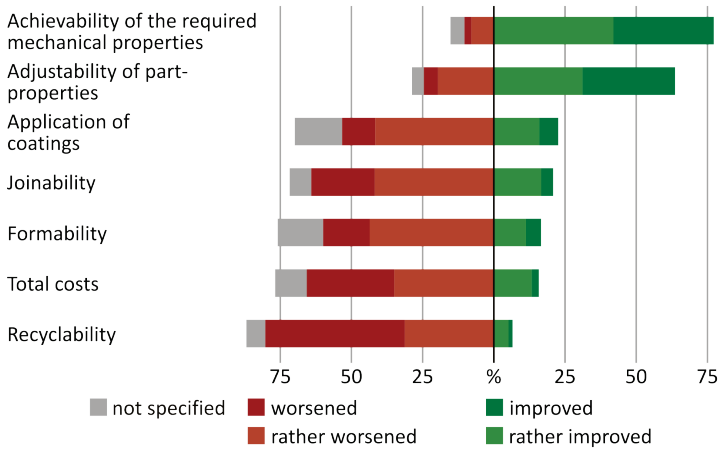


**Figure 2.** Impact of an increased use of multi-material design [1]

Additionally to the FOREL study the researchers continuously monitor technological developments and publish market analyses [3].

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## 3. Project structure and organisation

FOREL is a national, comprehensive, open and independent platform for the development of high-tech, lightweight system solutions for electric vehicles of the future. FOREL brings together established German R&D centres with industry leaders and has grown to a network of around 65 partners.
By offering pre-competitive and project-based exchange between partners and coordinating research projects, the platform facilitates rapid development in the fields of shaping, forming, joining, assembly, repair or recycling technologies. The project results and process chains are eventually linked to a comprehensive process network. By working so closely with industry, FOREL has the ability to transfer research results to industrial value chains directly.
Besides the research projects such as LEIKA, THIXOM or ReLei, FOREL has a comprehensive coordination project that holds the paths of the network together. The coordination project is organised by four research institutions from Dresden, Munich, Paderborn and Freiberg. Its main task is to continuously improve and adjust the overall focus of FOREL. Together with an established industrial board the partners of the coordination project align the orientation of further developments of lightweight engineering for the electric mobility. It acts as a link between the research projects and the NPE always focussing on the main target of turning Germany into the leading supplier and lead market of electric mobility. The organisation of FOREL including all projects, the industrial advisory board and the NPE is displayed in Fig. 3.

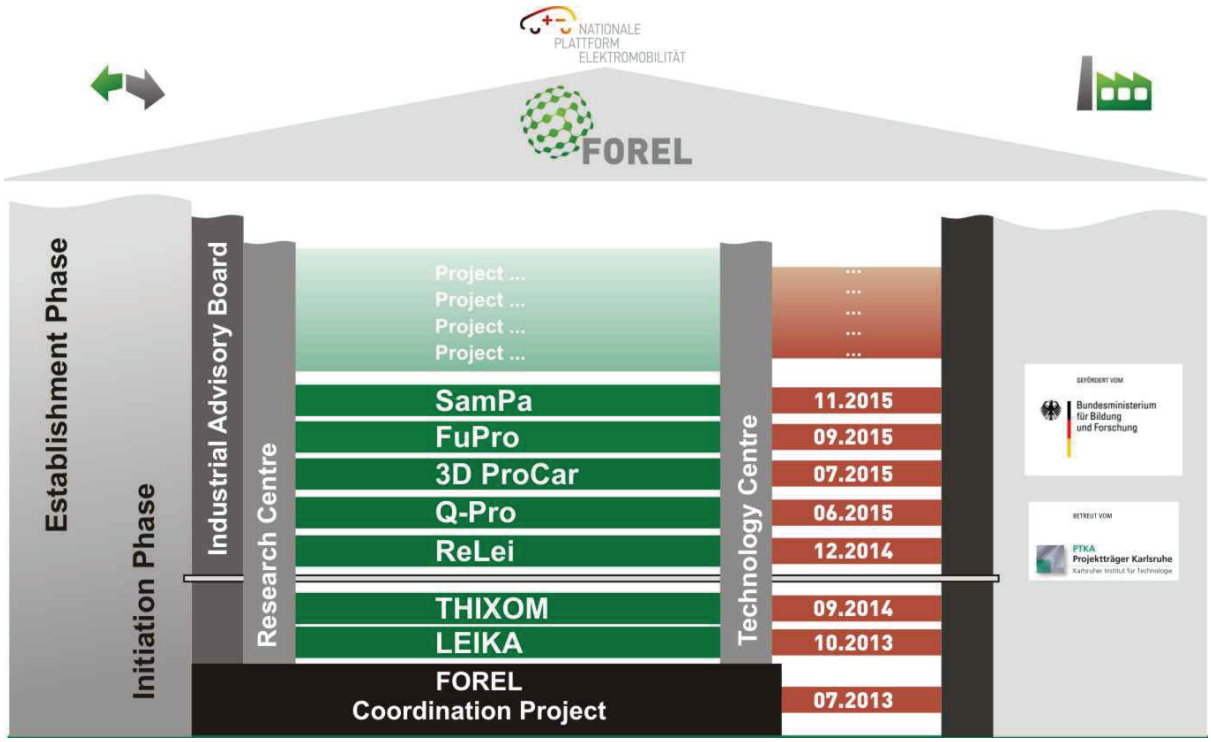


**Figure 3.** Visualisation of the FOREL project structure

## 4. A network of technologies and stakeholders

The core idea of FOREL is to involve all stakeholders of a process chain in order to identify technological, economic and ecological gaps. For this reason the FOREL network integrates different OEM, suppliers and research centres. The scientific investigations include material developments, novel design guidelines, simulation techniques, manufacturing technologies as well as quality control

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methods. As the FOREL consortia aim to establish continuous process chains they are focussing on the interfaces between the different stages of manufacturing. An important tool used for a clear documentation and visualisation of technological inter-dependencies is the process chain analysis. The on-line based software tool allows virtual modelling and even virtual planning of novel process chains. In order to offer a common platform for scientific exchange an annual FOREL colloquium is organised at the ILK in Dresden. Besides a presentation of current project results, new trends and future need for research are discussed. In addition to the continuing initiation of new FOREL research projects, FOREL also addresses the question of suitable advanced education. New and more flexible forms of training are required, which do not only aim at the next generation of engineers but also technicians and experienced employees from all areas of the companies. For this purpose the "FOREL Academy" was set up last year.

## 5. Conclusions

Considering the developments and trends in the electric mobility, it becomes clear that thinking outside one's own technical box will be an important prerequisite in future. A successful introduction of the electric mobility is essentially connected to strong partnerships and alliances. FOREL as an alliance of innovative partners in the field of lightweight engineering synergistically links the technologies to complex process chains that are capable for the large-scale production of electric vehicles. The multi material approach of FOREL takes not just one material into account, but the compatible combination of the suitable materials for the right application. This is strongly connected to new approaches in hybrid joining technologies and recycling strategies for the materials of the future as highlighted in the FOREL study. After all, the technology development approaches that are addressed inside clusters such as FOREL, mainly have to focus on an economic competitiveness.

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