Karlsruhe Institute of Technology

Division III – Mechanical and Electrical Engineering

wbk Institute of Production Science

ProLemo – Innovative Electric Motor Production

Technologies to Produce Efficient Lightweight Motors for Electric Vehicles

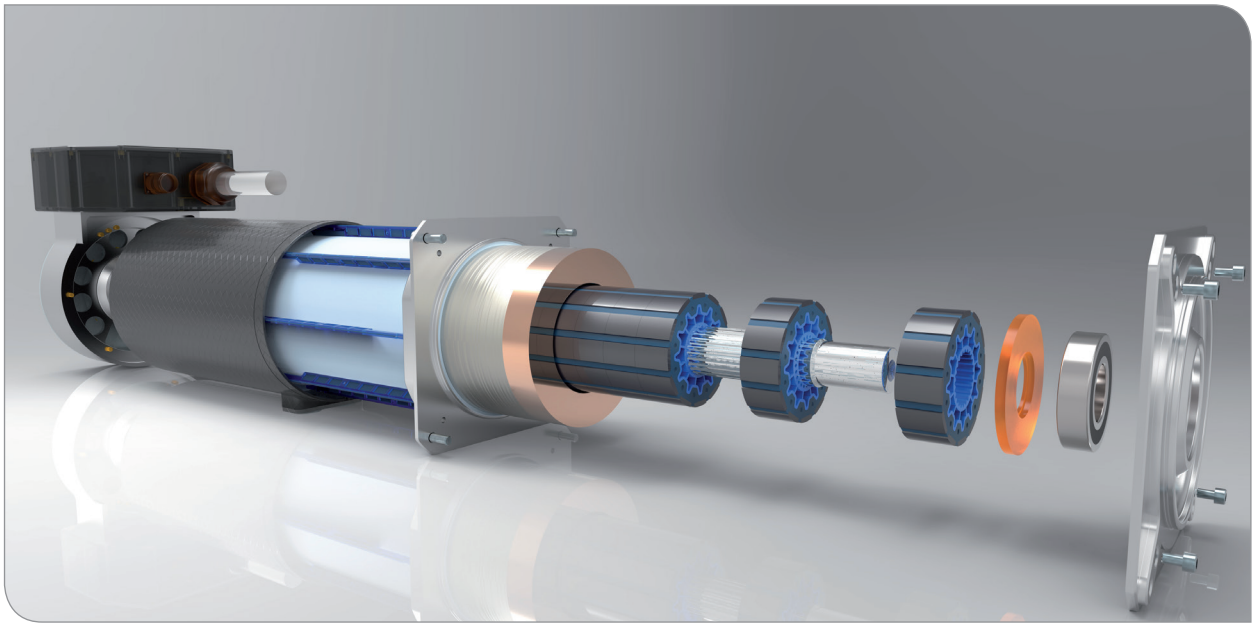
Existing electric motors of high performance are optimized for driving machines and plants, which is why their development, construction, and production focus on fatigue strength and service life. Size, efficiency, and weight often play a minor role only. Hence, these motors mostly are too heavy, too large, and too expensive for use in vehicles. To enhance their suitability for use in the electric mobility mass market, innovative series production and lightweight technologies were developed within the ProLemo project.

Cooperation along the Entire Value Chain

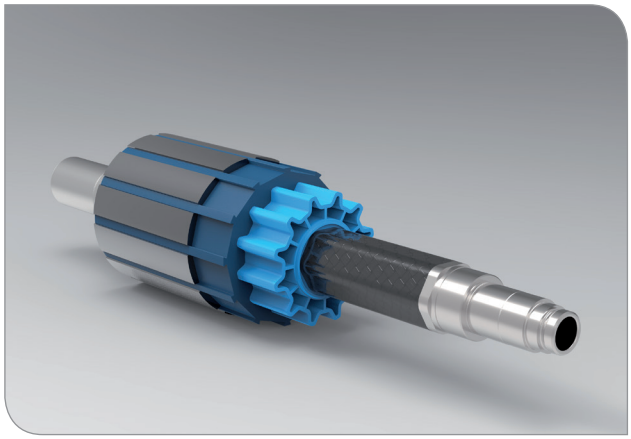
Along the entire value chain, Karlsruhe Institute of Technology with its Institutes of Production Science (wbk) and Vehicle System Technology (FAST) cooperated very closely with industry partners (WITTENSTEIN cyber motor GmbH, ARBURG GmbH + Co KG, INDEX-Werke GmbH & Co. KG Hahn & Tessky, and Aumann GmbH). Specific use of lightweight materials (fiber-reinforced composites, soft magnetic compounds) and a highly compact, automatically produced copper wire winding led to a weight reduction by about 20% compared to a reference motor of the same class. In particular, rotor weight was decreased, as a result of which the moment of inertia was reduced by about 15%.

Innovative Production Processes

Weight reduction in particular resulted from the development of a process to produce CFRP-steel hybrid shafts and a two-component injection molding process for the scalable manufacture of lightweight rotor disks from soft magnetic compounds (SMC). A lightweight housing made of CFRP with an integrated modular cooling system ensures optimum cooling of the stator winding. The latter is produced by an automatic needle winding process for a high degree of filling and a small external diameter of the



Setup of the ProLemo lightweight motor



CFRP-steel hybrid shaft with lightweight rotor disks as an alternative to a steel shaft with laminated steel stacks

stator. In case of an optimized assembly of the rotor components, no balancing step and no balancing disks are required. For the hybrid shaft, lightweight rotor disks, cooling of the housing, stator winding, and assembly with minimum imbalance, a prototype cell for the production of a lightweight motor was set up at the wbk Institute of Production Science. First rotors were manufactured and tested.

Result

- Development of a rotational molding process to manufacture CFRP-steel hybrid shafts.
- Manufacture of rotor disks from soft magnetic compounds as a promising alternative to punching and stacking processes of electrical steel.
- Further development of a flexible and automated process to manufacture a complex stator winding to increase the copper filling factor.
- Development of a process for the assembly of rotor components with minimum imbalance.
- Implementation of the production chain at the technical laboratory for e-drives of the wbk Institute of Production Science.
- About 20% weight reduction compared to a reference motor of the same performance class.
- Further development of the technologies conceived in the project.

Technical Data

ProLemo motor	
Type of motor	Permanently excited synchronous motor
Maximum power	90 kW
Rated power	51 kW
Maximum torque	204 Nm
Weight reduction	About 20% compared to reference motor

Karlsruhe Institute of Technology (KIT)
wbk Institute of Production Science

Prof. Dr. Jürgen Fleischer
Gotthard-Franz-Straße 5
76131 Karlsruhe, Germany
Phone: +49 721 608-44009
http://www.wbk.kit.edu/english/index.php

Contact:
Wilken Wößner
Phone: +49 721 608-28311
Email: wilken.woessner@kit.edu

Supported by:
Federal Ministry of Economics and Technology
on the basis of a decision by the German Bundestag