INNOVATIVE LIGHTWEIGHT DESIGN AND COOLING CONCEPTS FOR ELECTRICAL MACHINES USING ADDITIVE MANUFACTURING

The aim of this project was the successful implementation of additive manufacturing in electrical engineering. In order to introduce and exploit the advantages of additive manufacturing in electrical engineering, innovative application concepts were identified and investigated. This was achieved by the identification of innovative cooling and lightweight design concepts within engine components. However, the main focus of this project was very interdisciplinary. Therefore, this project was a collaborative project between the DMRC and the IAL (Institute for Drive Systems and Power Electronics) at Leibniz University Hannover, combining the expertise of alloy-design, design guidelines and mechanical as well as electrical characterization.

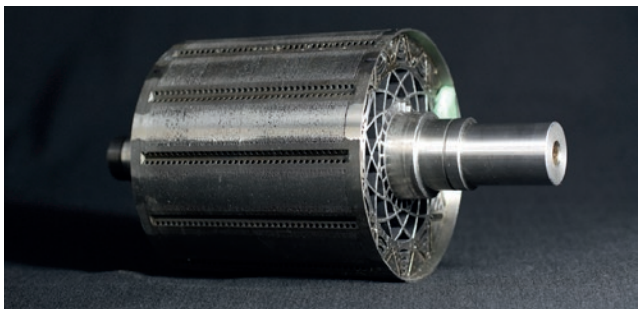

FIGURE 1: Additively manufactured rotor of a PMSM out of FeSi3%.

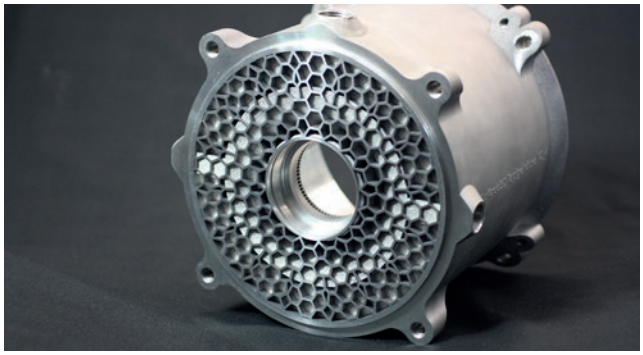

FIGURE 2: Additively manufactured housing of a PMSM with integrated cooling and lightweight structures out of AlSi10Mg.

PROJECT OVERVIEW

DURATION	11/2019 – 04/2022
PARTNER	ASTRO Motorengesellschaft; Beuckmann; Porsche; Dunkermotoren; OSWALD Elektromotoren; STÖBER Antriebstechnik; MSF-Vathauer Antriebstechnik
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Motivation

Despite the many advantages of additive manufacturing (AM), it is primarily used in aerospace and medical technology, thus in areas in which lightweight design and individualization have the highest priority. In other areas, it is only slowly establishing itself due to the high production costs in series production. Nevertheless, AM offers the potential of improvement and economical use in other areas.

In the field of electrical engineering, there is potential for improvement in form of lightweight design, cooling concepts and the functional expansion of individual components. Both the max. continuous power and the power density of electrical machines depend on the effectiveness of the cooling system. Heat dissipation at the point of loss generation is the most effective. Until now, it has not been economically feasible to manufacture the functionally optimized cooling channels required for this purpose using conventional manufacturing processes.

Aim

The aim of this research project was the integration of additive manufacturing into electrical engineering by designing and manufacturing an optimized permanent-magnet synchronous machine (PMSM). In the fabrication of electric motors, conventional manufacturing, in form of the lamination of electrical sheets, leads to restrictions on design freedom. These restrictions do not apply in additive manufacturing, which allows the integration of previously unproduceable concepts. An existing electric motor was optimized by integrating innovative cooling and lightweight design concepts into the existing motor components, possible through the design freedom of additive manufacturing. In addition, the geometry and microstructure of the rotor (Figure 1) and the shaft should be ideally support the magnetic flux in the motor. Despite the high production costs, the potentials of the component complexity and the high functional density increase the parts value and result in cost-effective production processes. The knowledge gained from the project shell be used specifically to develop new innovative products in electrical engineering in order to enter new markets with the help of additive manufacturing.