Complete Electric Motors in 3D-Printing

Electrical engineers at Chemnitz University of Technology/DE are printing the first electric motors from iron, copper and ceramics worldwide. With the help of metallic and ceramic pastes that are shaped layer by layer in an extrusion process and then sintered, researchers at the department of the Electrical Energy Conversion Systems and Drives at Chemnitz University of Technology have succeeded in printing complete electric motors.

Back in 2017, a 3D-printed coil was presented (Fig. 1) that can withstand temperatures over 300 °C. In the meantime, with a 3D-multi-material printing process developed in the department, it has been possible to print all the key components of an electric machine in one printing process. These components include the electrical conductors made of copper, which together with iron or iron-containing alloys effect the formation and alignment of the magnetic fields and the electrical insulators made of ceramic, which insulate the conductors from each other and against the iron components that make up the magnetic circuit.

Objective of the around two and a half year's work has been so far to increase the maximum service temperature of electric machines considerably. The Chemnitz-based researchers achieve this by replacing conventional, polymer-based insulating material with special ceramics that exhibit much higher temperature resistance. The permissible winding temperature of conventional insulation systems of maximum 220 °C can consequently be exceeded substantially, as a result of which the service temperature of electric machines is only limited by the ferromagnetic properties of the iron, which exist up to around 700 °C.

Keywords
3D-printing, multi-material process

Besides the higher temperature resistance, the ceramic insulation material also exhibits higher thermal conductivity. As a result, the heat loss in the conductors can be dissipated more quickly. In this way, the scientists achieve another important objective of their work: the increase in the power density of electric machines. Despite a process-related, somewhat lower electric conductivity of the copper, in special applications an increase in the efficiency is possible with a considerable reduction of the winding temperature.

Basis of the process that the Chemnitz-based researchers want to develop further to market maturity is the layer-wise extrusion of high-viscosity pastes. These contain particles of the required materials such as iron, copper or ceramics and specially tailored binders. To achieve the precision necessary for multi-material printing during metering of the pastes, the scientists are working closely with the company ViscoTec Pumpen- u. Dosiertechnik GmbH in Töging am Inn/DE.

The process also enables self-supporting structures, as a result of which components with closed and empty cavities can be fabricated. Such inner structures offer interesting approaches for efficient active or passive cooling concepts, If, in addition, support structures are used, almost any 3D-shape is possible. Another feature of the process is high material efficiency. Virtually, all the material input can be used for the printing process.

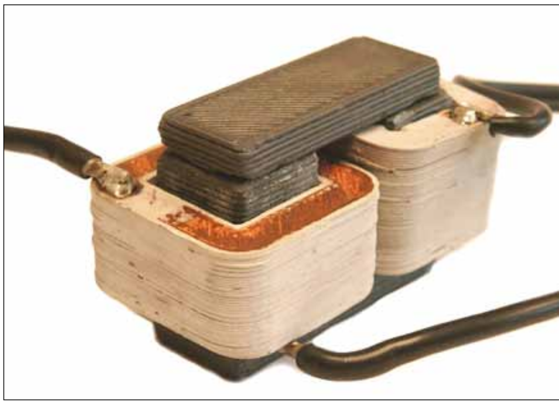

Fig. 1 3D-printed coil

The motor printed in the laboratory at Chemnitz University is a breakthrough.

Fabian Lorenz
TU Chemnitz, Germany

E-mail:
fabian.lorenz@etit.tu-chemnitz.de

www.tu-chemnitz.de/etit/ema/AMMM/index.php