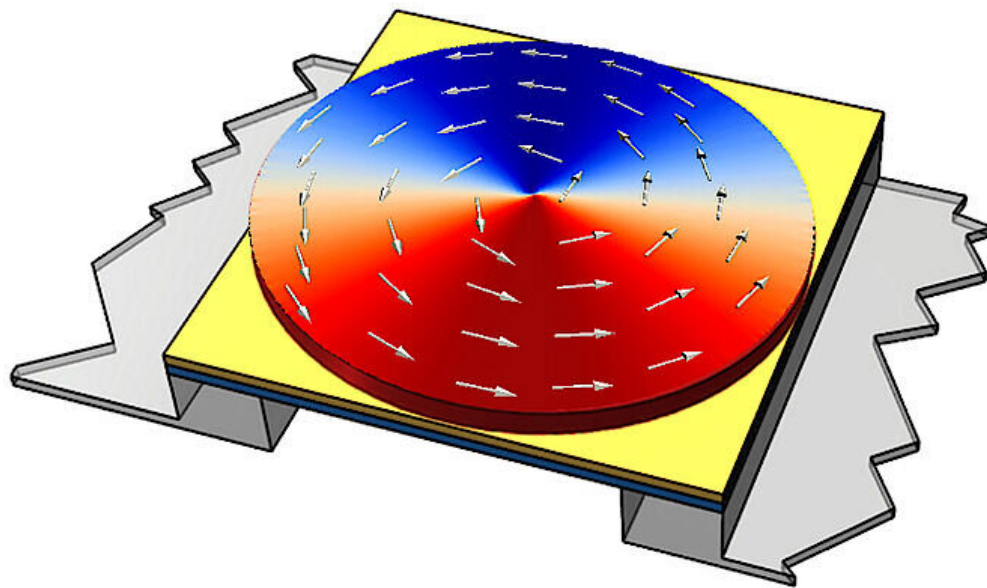


# Researchers investigate applications of magnetic sensors in the automotive and medical sectors

September 1 2020

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Further research goes into magnetic sensors and their future application. Credit: Dieter Süss et al.

In his Christian Doppler Laboratory, Dieter Süss and his partners from the field of practice investigate the possible applications of magnetic sensors in the automotive and medical sector. Süss's technology achieved

its first successes in ABS systems of vehicles and in magnetic resonance imaging.

Sensors that react to magnetic resistance changes have been used in hard disks for a long time. Dieter Süss and his team investigate how this technology can be implemented in other areas. The investigations are conducted in the Christian Doppler Laboratory Advanced Sensing and Materials that is part of the Faculty of Physics at the University of Vienna. In particular, the team examines so-called GMR and TMR [sensors](#).

GMR sensors are based on the discovery of giant magnetoresistance (GMR) for which Albert Fert and Peter Grünberg received the Nobel Prize in Physics in 2007. To put it simply, the two researchers discovered that the conductivity of materials depends, among other things, on the direction of magnetisation. TMR sensors, on the other hand, use the quantum mechanical phenomenon of tunnel magnetoresistance (TMR). TMR comprises a system in which two magnetic layers are separated by a non-magnetic layer. In the CD Laboratory, Dieter Süss and two partners from the field of practice investigated the possible application of GMR and TMR sensors in new sectors.

## **New sensors improve ABS systems**

In cooperation with the world's leading semiconductor manufacturer Infineon, the team solved a well-known problem in new GMR sensors used in ABS systems of vehicles: When the GMR sensors are installed in specific positions, the system becomes highly inaccurate with regard to the magnetic coding wheel. Dieter Süss says, "We found out that these inaccuracies are not the result of inaccuracies in the [manufacturing process](#). As an alternative, we developed a completely new sensor—the vortex sensor—that solves the problem and simplifies production at the

same time. We patented the sensor concept before [publishing it](#) in *Nature Electronics*."

For this innovation, the research project was nominated for the Houska Prize in 2019. Süss explains that the application of the new sensor design has far-reaching implications for [automobile manufacturers](#): "Infineon on its own needs around 180 million of these sensors per year to be able to measure the rotational speed of the vehicle wheels or parameters such as the steering wheel position for ABS systems."

## **The first 3-D-printed permanent magnets**

The research group achieved another remarkable success in cooperation with the magnet manufacturer Magnetfabrik Bonn: They were able to produce [permanent magnets](#) using additive manufacturing (3-D printing) for the first time. This process enables the rapid and cost-effective production of permanent magnets in complex forms. The three-dimensional objects consist of about 90 percent of magnetic material and 10 percent of polymer. If the object is exposed to a magnetic field at the end of the production process, it transforms into a permanent magnet.

The Viennese research team were the first to use this 3-D technology. Dieter Süss explains: "Our innovation attracted worldwide attention. It was even the subject of the cover story of an edition of *The Economist* in 2016." The simple, yet precise production of permanent magnets opens up a variety of new areas of application, including in the medical sector. In this regard, the Laboratory cooperates with the Vienna General Hospital (AKH) to investigate possibilities for improving [magnetic resonance](#) imaging (MRI).

## **Experience meets flexibility**

Dieter Süss's research is based on a special software developed by his team. It is used to describe the magnetic properties of materials. Leading hard disk manufacturers use the software, for example, for the optimisation and the design of GMR reading heads.

Concerning the remarkable successes of the CD Laboratory Advanced Magnetic Sensing and Materials, Süss says, "On the one hand, we have a lot of experience in the simulation of magnetic materials. On the other hand, the cooperation with our partners in the industry gives us the opportunity to conduct application-oriented research and to implement our innovations quickly. Without flexibility and rapid decisions of the Christian Doppler Research Association and our partners in the industry, we would have no chance of competing successfully on the international stage."

Provided by University of Vienna

Citation: Researchers investigate applications of magnetic sensors in the automotive and medical sectors (2020, September 1) retrieved 5 May 2024 from <https://phys.org/news/2020-09-applications-magnetic-sensors-automotive-medical.html>

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