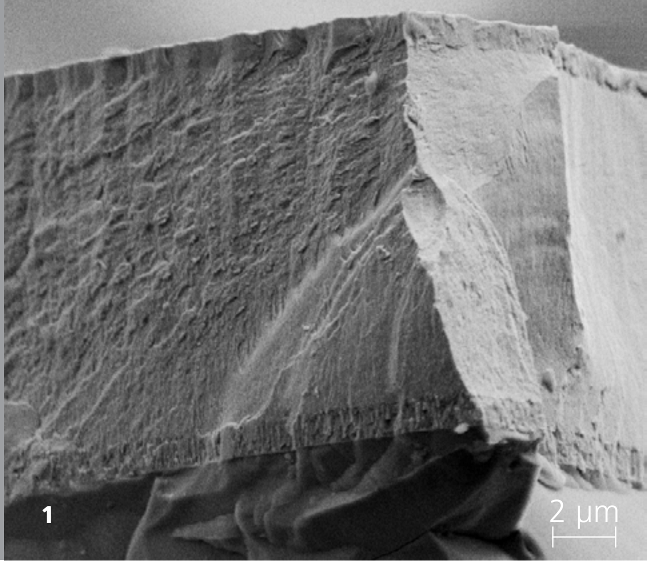

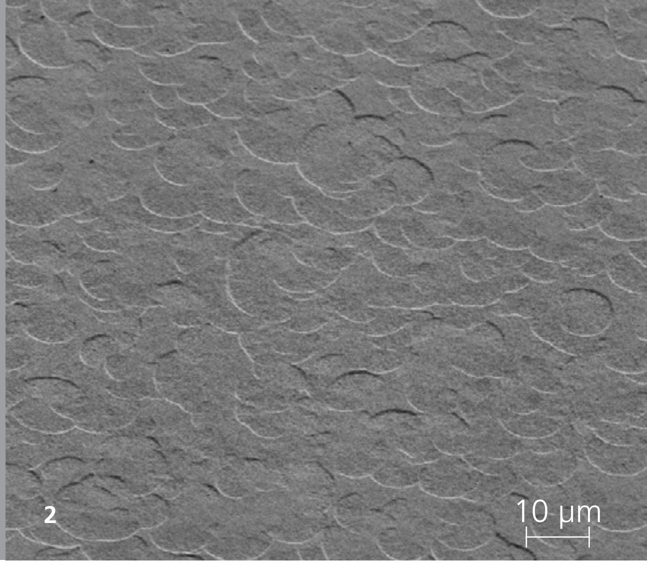

MAGNETIC LAYERS WITH GAS FLOW SPUTTERING

Magnetic layers have long been established as reliable and highly accurate information carriers, for example, in hard drives or on swipe cards. But even for mechanical and electromechanical elements, magnetic layers offer a great potential for measuring the position, speed or angle of moving parts in operation. They can also be used for coding workpiece information or as an element in miniaturized drives. For some time now soft and hard magnetic layers for different applications have been developed at the Fraunhofer IST.

Hard magnetic layers on technical surfaces

One application example is a precision angle sensor for which a magnetic layer is sputtered directly onto a commercial roller bearing. High demands are made of the magnetic and structural properties of coatings of this kind on technical surfaces, not least because their information is to be read off from a certain distance away. On the one hand, the magnetic layers must have not only a high remanence – in other words, a high residual magnetism – but also a layer thickness in the one- to two-digit micrometer range. On the other hand, they must have a high coercive field strength – that is, a high resistance to unintended pole reversal – to prevent information from being disturbed or overwritten by external fields in a harsh environment. At the same time they should be smooth, have little residual stress and be corrosion-resistant. Rare-earth magnetic materials, such as samarium-cobalt, are particularly suitable for these requirements since they have an exceptionally high energy product and can even be used at higher temperatures.

Gas flow sputtering of rare-earth magnetic layers

Any sputtering method can generally be used for the reliable production of smooth and compact layers. However, magnetron sputtering, which is in widespread use, is only feasible to a very limited extent especially for magnetic materials, since these materials disable the functional principle of the magnetron. Hollow-cathode gas flow sputtering, however, is very suitable for the deposition of magnetic materials. As a high-rate sputtering process with no magnetic field, this means that layer thicknesses even up to several tens of micrometers can be produced economically.

The scanning electron micrograph in Figure 1 shows a typical structure for a hard magnetic layer deposited by gas flow sputtering. A rare-earth magnetic layer 10 µm thick is sputtered onto a thin, adhesion-promoting and texturizing starting layer. It is topped by a thin layer of chromium which protects against corrosion and wear. It can be seen from Figure 2 that although

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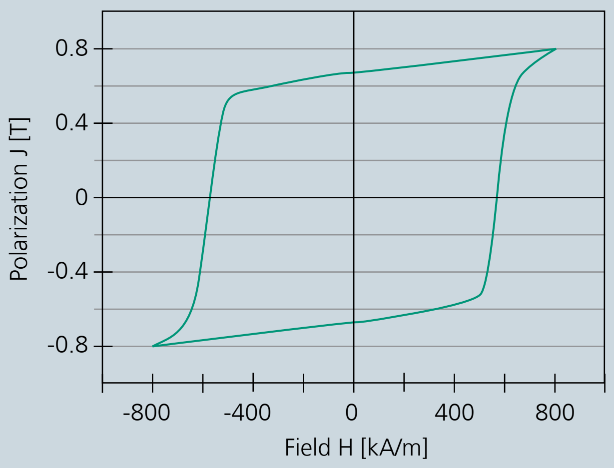
the surface has characteristic structures it is otherwise smooth and free of flaws. The associated hysteresis curve is shown in Figure 3. With a remanence greater than 0.6 T and a coercive field strength above 500 kA/m these layers have excellent hard magnetic properties.

Outlook

Magnetic layers have already been successfully deposited on metal alloys, semiconductors and ceramics. The range both of substrate materials used and of magnetic alloys available is being continuously expanded. In addition, different approaches to scaling up the coating are currently being investigated in order to make economically attractive production processes possible.

Hard-magnetic hysteresis of a gas-flow-sputtered rare-earth magnetic layer 10 µm thick.



1 Typical layered structure (SEM micrograph) with adhesion-promoting layer (bottom), magnetic functional layer (middle), and wear and corrosion protection layer (top).

2 SEM view of the surface showing low roughness and defect density.

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