# STUDY OF THE MAGNETIC FIELD OF THE FERROMAGNETIC FILM THICKNESS SENSOR BASED ON THE HALL EFFECT

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Coating methods are actively developing and are widely used to increase the reliability and durability of machine and mechanism parts by forming a protective surface metal layer with enhanced functional properties. However, there are some technical challenges when it comes to the process of measuring coatings. To date, various scientific associations have created a large number of inductive sensors that can be used to measure coating thicknesses both in laboratories and factory conditions. All types of sensors depend on the methods on which they are based.

It is important to maintain control over the sputtering process, in particular the thickness of the ferromagnetic material layer, in real-time. For this, a measuring device based on the Hall effect to measure the metal layer would be sufficient. Many researchers [1-5] put forward requirements for such a sensor. It is expected to have high reliability, allow for further improvements in accuracy, and be compatible with computer hardware during automated measurements. This type of equipment uses a constant magnetic field, and the measuring element is the Hall sensor that responds to the strength of the magnetic field.

Various improvements are being developed to methods of measuring the thickness of sprayed foil. In particular, the computational converter can be enhanced in the following characteristic ways: extension of the measurement range, increase in precision of calculation and measurement, providing higher sensitivity of the device. These requirements can be met, by relying on high-quality mathematical and computer models of the device.

The measuring system of the electromagnetic transducer consists of an inductor with a high Q-factor and a measuring plate based on a Hall sensor. This sensor measures film thickness by the witness method.

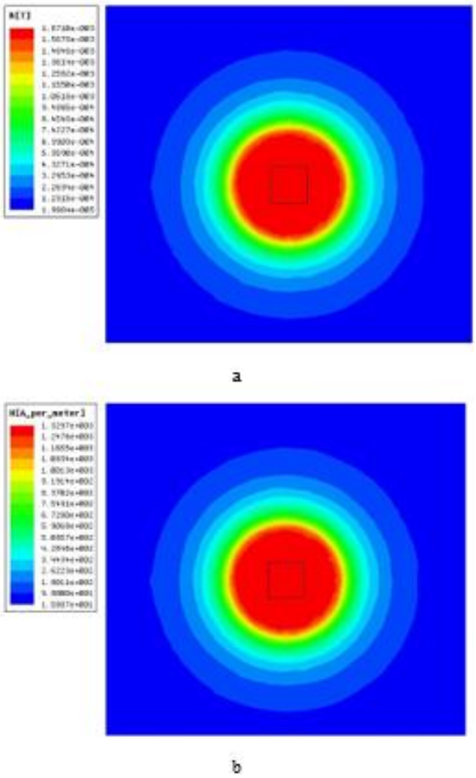


Fig. 1. The effect of a constant magnetic field in the middle part (parallel to the x,y plane) on a square measuring Hall plate: a) distribution of magnetic induction b) distribution of magnetic field strength.

Ansoft Maxwell 13.0, software for modeling electromagnetic fields, is used for the numerical estimation of the measuring transducer based on the Hall effect. In general, numerical methods rely on discrete calculation schemes and allow obtaining an accurate solution during the simulation process [6, 7].

The experimental model in Ansys Maxwell includes the following components: an induction coil suspended above a glass plate (upon which a ferromagnetic coating should be sprayed during the operation of the sensor), and a gold Hall plate located below the glass plate without a gap.

A 3-d model of a coil was developed, with the following parameters: its diameter and height are both 150 mm; the wire within the coil is 0.33 mm in diameter; a glass pad is sized 300 x 300 x 10 mm; a square golden sheet with dimensions 50 x 50 x 1 mm is utilized as a measuring surface for the Hall sensor. 500 A of DC current flows through the solenoid, while 30 mA are applied to the plate.

The golden plate is a sensor that measures the strength of a part of the magnetic field. Therefore, the electric field of the coil, relative to its strength, changes the uniformity of the current inside the golden plate.

With the help of the developed computer model, the distribution of magnetic induction and magnetic field strength (Fig. 1) in the central section (parallel to the xOy plane) was obtained at a distance from the coil to the Hall plate of 10 mm.

The proposed sensor on the Hall effect belongs to non-destructive testing devices used in the field of mechanical engineering and machine repair, and can be used for measuring the thickness of the protective ferromagnetic metal coating that is sprayed over machine parts.

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