MAGNETIC SENSORS WITH NANOCRYSTALLINE AND WIRE CORES

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Magnetic nanocrystalline alloys have high relative permeability in the order of 100 000, low coercivity and high saturation induction. This will make them ideal material for very precise AC current transformers. Nanocrystalline particles in these alloys are dispersed in a matrix of amorphous magnetic material. This is why they achieve high permeability. Nanocrystalline materials can be annealed to achieve flat hysteresis loop with a constant relative permeability of typically 5000, which can be used to increase their resistance to DC component of the measured current. The amplitude error is constant and can be easily compensated. DC current transformers are based on fluxgate effect. Using nanocrystalline alloy and simple electronics, these devices can achieve 0.2 % accuracy with small size and low power consumption. Rogowski coils are also used to measure AC current, mainly for protection purposes, but also for the measurement of power and energy. They have excellent linearity, but due to air core technology they have low sensitivity. We will show that using nanocrystalline composite cores with constant permeability can increase the sensitivity of these devices and improve their resistance against external magnetic fields. In this case the required relative permeability is only in the order of 10, and the material should be extremely linear. Microflakes of nanocrystalline alloy in non-magnetic matrix is an example of such material. Another application on nanocrystalline alloys are position and speed sensors with linear armature. Due to the low thickness and high resistivity of these materials, the working frequency can be extended, which increase the sensitivity. In this case using flat loops does not improve the device linearity, but increases its resistance against external fields. The possible way how to improve the nonlinearity is optimization of shape of the magnetic armature.

Magnetic microwires are usually amorphous, but nanocrystalline microwires were also prepared. Microwires are used in magnetoelastic force sensors, surface acoustic wave-based position sensors and in magnetic sensors with high spatial resolution. We will show how the magnetic field resolution can be increased using a wire array. Magnetic nanowires are mainly produced by electrodeposition into the pores in membranes. They usually have large coercivity, which is an advantage for magnetic storage, but disadvantage for most sensor applications. Electrodeposition under magnetic field is one way how to modify the nanowire properties. The effective sensitivity of nanowire-based magnetic sensors strongly depends on coil geometry.