HSM-02

Step-like hysteresis behaviour of Co-based amorphous microwires array

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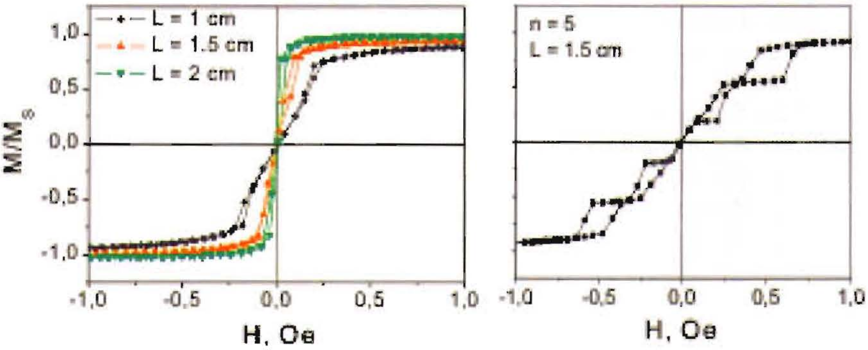
Abstract

Nowadays there are the numerous applications for using amorphous ferromagnetic microwires due to their small size and unique properties like extra-soft magnetic behavior or rectangular hysteresis loop. In the present work we consider the possibility to create a decoding system based on the array of Co-based non-bistablemicrowires contrary to the common decoding system based on magnetically bistable Fe-based microwires. The magnetization reversal in the single and in arrays of Co-based amorphous microwires with different length was investigated using Vibrating Sample Magnetometer. Co-based microwire with diameter of 30 mkm was produced by quenching and drawing technique. The number of the wires composed arrays was varied from 1 to 5. The distance between the wires in the arrays was made equal to 0, 1 or 2 diameters of microwire. The lengths of the array changed from 0.5 up to 2 cm. The hysteresis loop for single Co-based microwire with different lengths of 1-2 cm has a shape usual for the wire with circular anisotropy whereas the hysteresis loop for microwires arrays has step-like behaviour. It was found that the microwire length increase leads to changing the hysteresis loops near the saturation fields (see Figure) but keeps the coercivity. When the length was 1 cm and more, the magnetization of the arrays occurs one-by-one in consecutive order – the hysteresis loops have the step-like shape(see Figure), the height of each step corresponds to one wire magnetic moment change. The width of the step depends on the inter-wires distance and their length.



BIS-I4

Optimizing GMR- and TMR-devices for sensing

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Abstract

Giant magnetoresistance (GMR) as well as tunneling magnetoresistance (TMR) sensors are considered one of the first real applications of nanotechnology. They consist of nm-thick layered structures where ferromagnetic metals are sandwiched by nonmagnetic materials. Such multilayered films produce a large change in resistance (typically 10 to more than 200%) when subjected to a magnetic field, compared with a maximum change of a few percent for other types of magnetic sensors. This technology has been intensively used in read heads for hard disk drives and now increasingly finds applications due to the high sensitivity and signal-to-noise ratio. Additionally, these sensors are compatible with miniaturization and thus offer a high spatial resolution combined with a frequency range up to the 100 MHz regime and simple electronic conditioning. In this talk, we first discuss optimization procedures for different sensing tasks and then present two examples for future applications: the use of materials with large magnetostriction enables sensing of mechanical stress very locally as demonstrated by detection of the bending of an AFM cantilever, and in biotechnology the detection of magnetic particles enables the quantitative measurement of biomolecule concentrations.

BIS-I5

Novel design of electromagnetic tweezers

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Abstract

Advances in nanotechnology gave rise to the growing interest in the study of methods of manipulation of micro and nano-objects. The main attention is focused on the following systems: optical tweezers [1], atomic force microscope [2] and magnetic tweezers [3, 4]. The main advantages of the magnetic tweezers are the low cost and simplicity of use. However, the range of their application is reduced due to shortcomings like, for example, the remanent induction of the core and interaction between ferromagnetic cores. We present the electromagnetic tweezers design that allows manipulating the magnetic particles by using the field gradients generated by electric currents flowing through the non-magnetic microwires. Arranging wires in different consistency and geometric shapes allows the controllable particle movement either in two or three dimensions. A system of planar microwires was fabricated and tested with various geometries (parallel and zigzag), dimensions in the range of 25-100 μm and chemical compositions (Al, Cu/SiO2, Au/Ti). Forces acting on the magnetic particles with the magnetic moment of $0.2\text{-}2*10^{-10}$ Am^2 at distances up to 1 mm had been experimentally measured. A working prototype were built and used in several experiments. The electromagnetic tweezers were tested for cytotoxic effect on human adipose-derived multipotent mesenchymal stromal cells (hAMMSCs). Results will be presented and discussed. The maximum force exerted on the particles in the centre of the 2x2 mm^2 working area was estimated to be in 3 - 30 pN range [5].

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HSM-P13

Domain wall dynamics in ferromagnetic microwires tuned by magnetoelastic interaction

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Abstract

Studies of magnetization reversal of two dimensional structures attract increasing interest due to its connection with the development of novel spintronics [1] and nano-object manipulation [2]. Amorphous magnetically soft glass-coated microwires form part of perspective magnetic materials suitable for the prospective applications related to the coding systems [3], magnetic field and stress sensors [4], and biomedicine [5]. Due to its amorphous structure the formation of the micromagnetic structure and the dominate remagnetization mechanism are defined by the magneto elastic energy.

In our work we considered the separate and combined influence of the parameters determining the magnetization reversal of amorphous ferromagnetic microwires paying the particular attention to the domain wall dynamics. We investigated the series of Fe- and FeCoNi-based microwires.

We showed that one of the effective ways to control the magnetic properties and the domain wall dynamics is an annealing. The annealing of Fe-based microwires results in the domain wall velocity increase up to 1.6 times (2400 m/s).The annealing of FeCoNi-based microwires, which had the S-shape hysteresis loop in as-cast state, under applied stresses leads to the drastic changes of the micromagnetic structure and the magnetization reversal process – after annealing the microwires become magnetically bistable. The value of the switching field is strongly depending on the annealing conditions, and hence, can be easily manipulated. Additionally, the domain wall mobility for such microwires is much higher than for the originally bistable microwires. This makes such microwires as promising candidate for the incorporation in novel devices.

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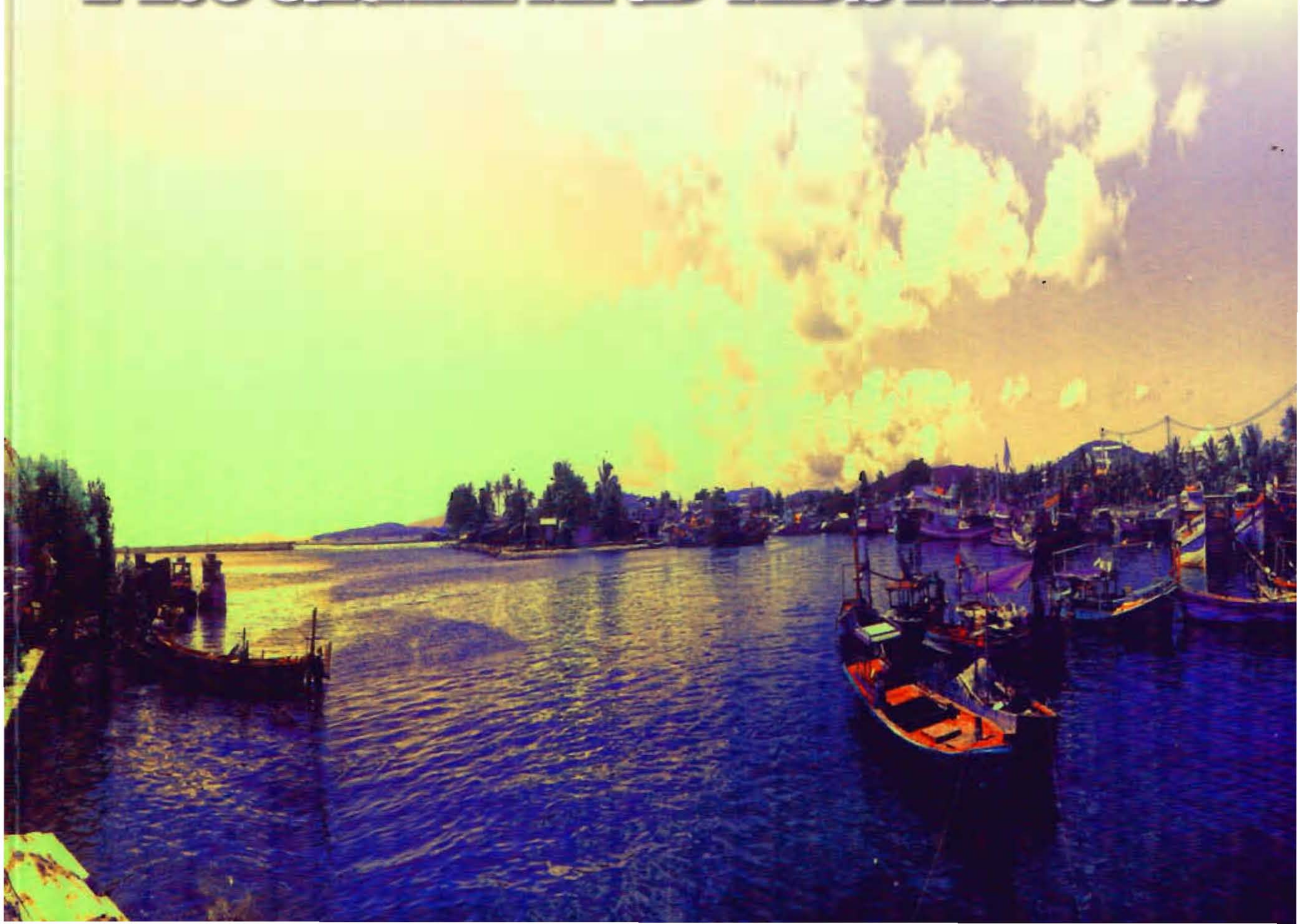
PROGRAM AND ABSTRACTS



ABOUT THE SYMPOSIUM

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Following the previous symposiums (ISAMMA 2007, ISAMMA 2010 and ISAMMA 2013), this In Symposium on Advanced Magnetic Materials and Applications (ISAMMA 2017) is held on 10-13 2017 in Phu Quoc, Vietnam. The Symposium topics are:

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3. Spintronics Materials and Devices
4. Magnetic Nanostructured Materials
5. Multifunctional Magnetic Materials
6. Spin Dynamics and Micromagnetics
7. Magnetic Materials for Applications
8. Symposium "Bio-initiative Spintronics"
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