

# INFLUENCE OF THE ORDERING DEGREE OF NICKEL NANOWIRE ARRAYS ON THEIR MAGNETIC AND MAGNETO-OPTICAL PROPERTIES

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The effect of the ordering degree of Ni nanowire array on its magnetic and magneto-optical properties has been investigated. Nickel nanowires were embedded in an alumina matrix and fixed to a Si substrate. Two different fabrication processes of the Ni nanowire arrays have been followed. The first one is based on imprint lithography, and it is described in detail in ref. [1]. In the second fabrication method, a two step anodisation process based on the Masuda approach [2] has been used. As an example, scanning electron micrographs of an array of Ni nanowires with length  $\sim 4 \mu\text{m}$ , column spacing 500 nm, and column diameter 180 nm are shown in Fig. 1. The arrays obtained via imprint lithography (Fig. 1(a)) show a perfect hexagonal arrangement on a  $\text{cm}^2$ -scale with a deviation in diameter of less than 2%. The nanowire arrays obtained via self-ordering anodisation (Fig. 1(b)) exhibit a 2D polycrystalline arrangement with short range ordering and a larger deviation of the nanowire diameter ( $\sim 12\%$ ).

The hysteresis loops were measured by SQUID magnetometer for both samples in the direction of the nanowire axis. In the case the nanowires have a monodisperse pore diameter and they are arranged monocrystalline, a coercive fields of 230 Oe is measured. The second sample exhibits a more reduced coercivity of 180 Oe, ascribed to larger dipolar interaction in the nanowires array. This is based on the larger deviation of the nanowire diameter and the higher disorder of the magnetic array.

In-plane disorder in the hexagonal array of nanowires and its effect on the hysteresis Kerr effect loops has been studied. Both, polar and transverse Kerr configurations have been employed. The sensibility of the Kerr system is increased by changing the wavelength used to measure the Kerr loops.

Fig. 2 shows the rotation angle (a) and the variation of the reflectivity (b) for a Ni nanowire array with wire length 700 nm, diameter 30 nm, and spacing 100nm fabricated by self-ordering[3]. Both curves have been normalised to their maximum values. As can be observed, the spectra have a peak around 3 eV. This peak is due to a plasmon resonance of the Ni nanowires. The line corresponds to a simulation made using a transfer matrix formalism, the effective dielectric tensor of the Ni nanowires layer has been computed within a self-consistent approach [4] and assuming a random arrangement of wires with no interaction between them. For these samples the amount of Ni in the layers is about 15%. The oscillations are due

to optical interference effects between the layer and the Si substrate that are not present in the experimental spectra due to surface roughness.

Fig. 3 shows the spectra for the two samples corresponding to Fig. 1. As can be seen, the shape of the spectra depends on the degree of ordering. The peak position is shifted to smaller energies for the mono-domain sample and its signal is greatly increased. These nanowires form an ensemble with wire distances exceeding those allowing near field coupling and thus interacting via their dipolar fields which interfere to form collective radiation [5].

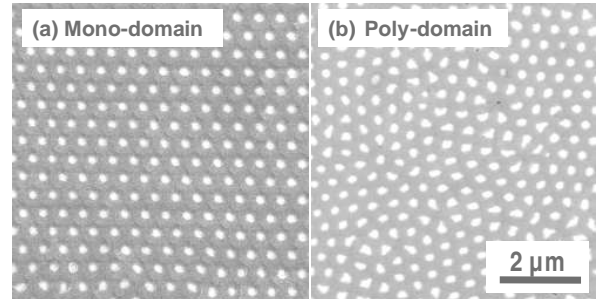


Fig 1: Scanning electron micrographs of nickel filled alumina templates fabricated via imprint lithography (a) and using two steps anodisation process (b).

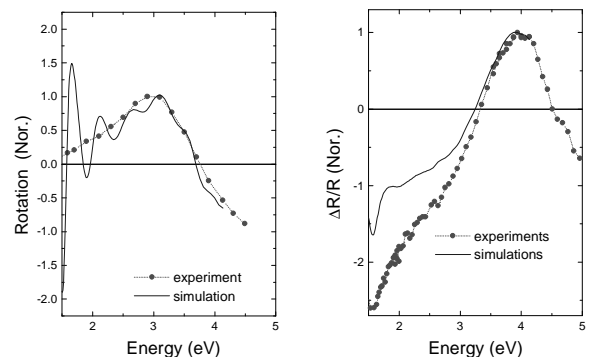


Fig. 2: Magneto-optical spectra of 100 nm-period Ni nanowire array with 2D-polycrystalline arrangement obtained in Polar (a) and Transverse (b) configurations.

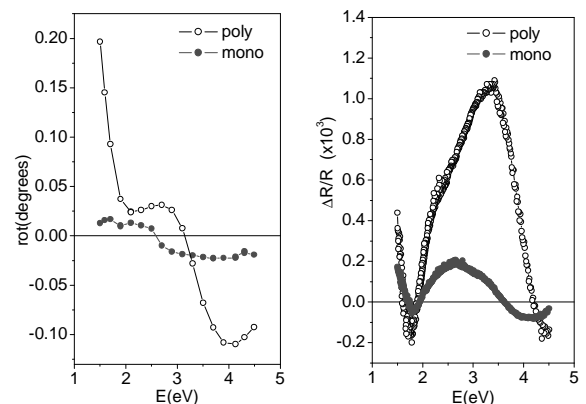


Fig. 3: Magneto-optical spectra of 500 nm-period Ni nanowire array with 2D-poly- and monocrystalline arrangement obtained in Polar (a) and Transverse (b) configurations.

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