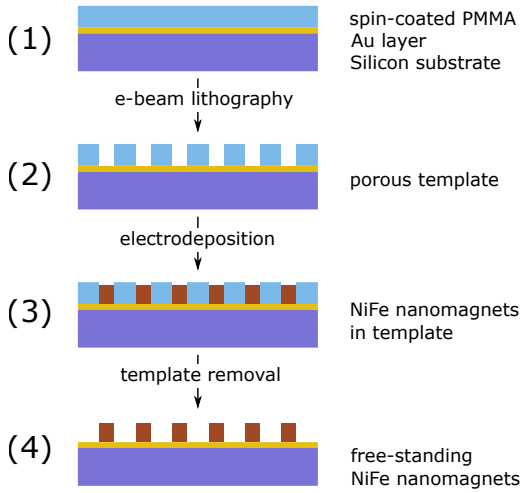
Supplement S1 - Method Details

January 22, 2021

1 Sample Fabrication

Each sample was fabricated in four steps (see Fig. 1). First, a thin (≈25 nm) gold layer was thermally evaporated on a on a 5 nm chromium adhesion layer on top of a silicon substrate. Then spin-coating of a polymethyl methacrylate (PMMA) layer (< 200 nm) on top was performed. With electron beam lithography, pores with a diameter of ≈35 nm arranged in a triangular lattice were created in the PMMA. NiFe nanomagnets were manufactured by electrodeposition into the porous PMMA templates on the Si-Au substrate. In a last step, the PMMA template was dissolved in acetone.



Fabrication scheme: (1) The sample consists of a silicon substrate with a gold layer and spin-coated PMMA resist on top. (2) Pores arranged in a triangular lattice are created with e-beam lithography. (3) NiFe nanomagnets are electrodeposited into the porous template and (4) the PMMA is dissolved in acetone.

1.1 Templates

PMMA 950k 3% resist was used for spin-coating at a speed of 3000 rpm. Development of the resist was carried out in a Hamatec Spraydeveloper with a Methyl isobutyl ketone (MIBK) : Isopropyl Alcohol (IPA) 3:1 developer for 45 s. In a next step, the samples were rinsed in IPA for a total of 60 s, while adding deionised water for 5 s after 30 s before spin-drying was performed.

Triangular Pore Lattices were fabricated by electron-beam lithography in an EPBG5000PlusES setup. The symmetric lattice (a = 70 nm) was fabricated with a dose of 250 μC cm^{-1}, the symmetric (a = 60 nm) and 10% compressed lattice (a = 60 nm) with a dose of 235 μC cm^{-1}. In order to pattern areas in the range of cm^2, we used a high-frequency single-shot mode, which yielded exposure times in the order of 27 hours, and 18 hours for the symmetric (a = 70 nm) and for the symmetric (a = 60 nm) and 10% compressed (a = 60 nm) lattice, respectively.

All templates were treated with O_2 plasma in an Oxford Plasmalab 100 (RIE) 100 for 15 s prior electrodeposition.

1.2 Electrodeposition

Galvanostatic electrodeposition was carried out in a bath containing 0.6 ,mol l^{-1} $Ni(SO_3NH_2)_2$, 0.0175 mol l^{-1} $FeSO_4$, 0.5 mol l^{-1} H_3BO_3, 0.007 mol l^{-1} $CH_3(CH_2)_{11}OSO_3$ (SDS), 0.0109 mol l^{-1} $C_7H_5NO_3S$ (saccharine) and 0.25g l^{-1} $C_6H_8O_6$ (ascorbic acid). A titanium platinised anode mesh was utilized as an anode and Ag/AgCl was used as reference electrode. All presented samples were created with an on/off pulse deposition of 10 ms and 90 ms respectively and an applied current density of -70 mA/cm^2 by using a Metrohm Autolab PGSTAT302N potentiosatat for a deposition time of 100 s. The deposition temperature was held at 35 °C in a double-walled electrochemical cell.

2 Composition

The composition of the samples was measured by a Thermo Fisher Scientific X-ray Fluorescence Spectrometer. The measurements revealed the approximate composition of 56 at.% Ni and 44 at.% Fe.

3 Imaging

Sample images were recorded with a Tescan Lyra scanning electron microscope.