

Fabrication of nanomagnetic spin ice arrays of CoFeB with improved resist profile for lift off of sputtered films

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Lift off is a commonly used process for transferring lithographic patterns into various metals. Most often thermal or electron beam evaporation is used to deposit the metal films, but some materials must be deposited by sputtering. These sputtered films are typically very conformal making a clean lift off very difficult. In this work, islands of a magnetic alloy of cobalt, iron and boron are fabricated in a spin-ice array by electron beam lithography and lift-off. These carefully engineered nanostructures, with features < 100 nm, can be used to build model systems for testing physical theories when suitable ones are not provided by nature. Large arrays (several mm^2 's) of these nanoscale magnetic islands are required for synchrotron and neutron studies. The various melting points of the CoFeB alloy metals require the material to be deposited by sputtering. The properties of the magnetic islands are strongly dependent on the uniformity of the thickness. By changing the electron beam energy from 100 kV to 30 kV we were able to improve the lift-off process but still found “fins” at the edge which resulted in degraded magnetic performance. Further use of development temperature gave a sufficient resist profile to ensure uniform islands (fig. 1). We will present results at various accelerating voltages and development temperatures and discuss the optimization of these factors giving the best lithographic and experimental results.

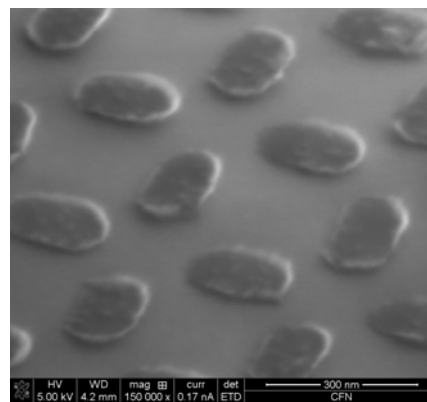
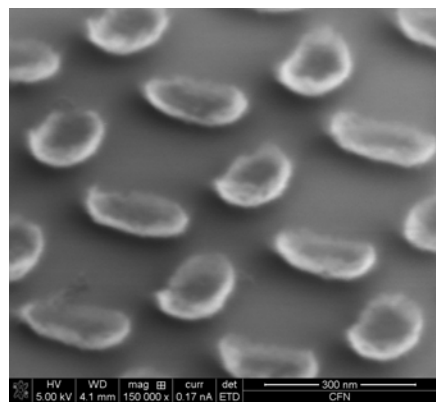


Figure 1. Array of nanomagnetic islands of CoFeB alloy fabricated by electron beam lithography, resist development, sputtering and lift off. The sample on the left was developed at 30C and shows raised “fins” at the edges of the islands. The sample on the right was developed at 20C and shows a uniform profile across the island.