The semi-metallic Fe3O4 films have attracted interest by the characteristic of combining a 100% spin polarization with a high Curie temperature [1] and have a relatively high conductivity [1]. These have been of great interest due to the properties of spin in an insulating material, therefore, are candidates for spintronic applications [2], such as magnetoresistive devices or magnetic tunneling junctions [1, 3]. It has also been of great interest to study the transition temperature Verwey and transport properties observed in thin films of magnetite [4].

Magnetite thin films were produced using the sputtering RF (radio frequency source) deposition system. The thin films were deposited on a silicon substrates. The formation of the magnetite after the deposition was confirmed by x-ray (XRD) diffraction and vibrating sample magnetometer (VSM). The magnetite films presented a magnetic saturation near 85 emu/cm³ at longitudinal direction (easy magnetization direction). The targets to sputtering were produced by compression of magnetite nanoparticles previously produced by chemical method of co-precipitation from mixing of iron salts and ammonium hydroxide. Fig. 1 shows TEM micrograph of magnetite nanoparticles: (a) bright field, (b) dark field, (c) its respective selected area electron diffraction pattern.

Periodic arrays of circles and squares were produced by electron beam lithography combined with sputtering deposition and lift-off process, a squares array of 1 μm and arrays of circles of 1 μm, 500 nm and 250 nm in diameter formed of a magnetite film 80 nm thick. The first step was the preparation of polymethylmethacrylate (PMMA) film of 250 nm thick by spin coat method on silicon substrate. At the second step, this substrate was written by electron beam and later, immersed into acetone solution for some seconds to produce the mask of the arrays. Then, the magnetite film was deposited onto the lithographed sample by RF sputtering. Finally, the sample was immersed in acetone until all the PMMA film has been lifted-off. The film thickness, shape, size and separation between the figures which comprise standards lithographed can influence the ease with which the mask is withdrawn from PMMA.

Scanning electron microscopy (SEM) and atomic force microscopy (AFM) images provide additional topographical information. The AFM provides good topography and thickness information. Fig. 2 show the AFM topography images of the shapes corresponding to different arrays.

References:
Fig. 1: TEM micrograph of magnetite nanoparticles: (a) bright field, (b) dark field, (c) selected area electron diffraction pattern.

Fig. 2: AFM images of the shapes corresponding to different arrays: (a) 250 nm circles, (b) 500 nm circles, (c) 1 μm circles, (d) 1 μm squares.