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Optimization of e-beam exposure parameters for the electrodeposition of magnetic nanostructures on rigid substrates

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Studies on the magnetic and electrical transport properties on magnetic nanowires and nanotubes to observe confinement effects, including spin dependent ones, are envisaged and new physical phenomena expected. For practical purposes, instead of working only with soft Al-foil substrates covered with extremely brittle anodized alumina, it becomes important to fabricate Anodic Aluminum Oxide (AAO) directly integrated with commonly used Si/SiO_2 or glass (rigid) substrates.

This work targets the development of a hybrid nanofabrication process combing electron beam lithography (EBL) and electrochemical techniques (anodization and electrodeposition) to grow nanowires and nanotubes embedded in thin film AAO on Si substrates. Here, we focused on the optimization of the EBL exposure parameters for the fabrication of patterned electrodes for electrodeposition.

EBL parameters were optimized for dense arrays of dots and rings, with a particular emphasis on dose and developing time. In this case, the proximity effect can lead to a 30-50 % deviation from the nominal size and was shown to be affected by the shape, size and packing density of patterns, to depend on processes conditions and backscattered electrons (Figure 1).

Finally, using a Si substrate provides additional compatibility with standard optical lithography techniques, e.g. to define electrical contacts to access the single nanostructures, thus providing easiness of integration for physical properties characterization while potentiating further applications.

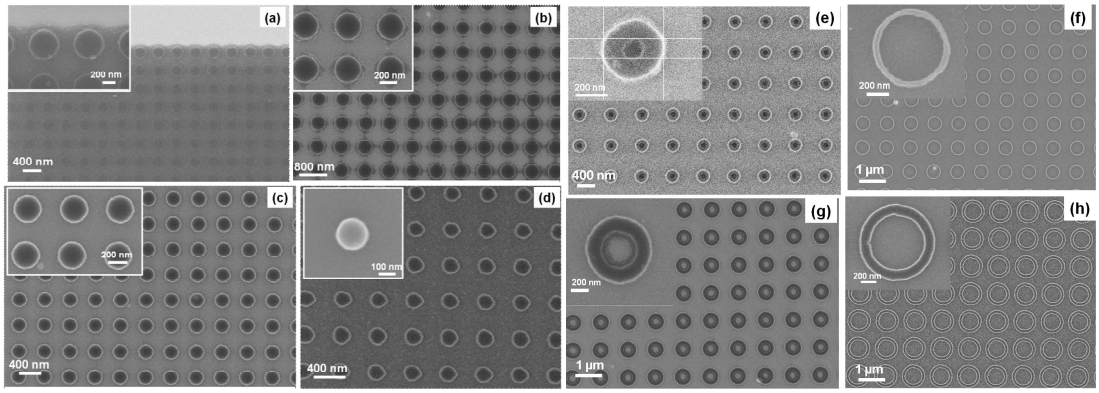

Figure 1:Examples of dense arrays of dots and ellipses for different nominal sizes, exposure and developing conditions, all affecting the final size of the nanostructures