Fabrication of individual nano-magnets and nano-magnet arrays by Electron-beam-induced deposition and Focused-ion-beam modification

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During the past decade(s), most of the experimental work on magnetic nano-structures has been utilizing optical and electron beam lithography as a means of sample fabrication, as well as nano-particle growth using wet chemistry. Recently, also other techniques have been developed and utilized to enter the realm of ultra-small dimensions for nano-magnets, such as Focused Electron-beam-induced deposition (FEBID) and Focused-ion-beam modification. FEBID has been established as a one-step technique for the fabrication of 1-, 2- and 3-dimensional nanostructures. In the last few years, there has been a growing interest in the development of FEBID processes for magnetic materials, namely for Fe, Co and Ni [1], which may provide a new route for the fabrication of magnetic nano-devices as well as complex nano-magnet designs. Since the magnetic properties of these three metals are strongly correlated with their purity, it is of crucial importance to fabricate ferromagnetic and conductive structures with the highest possible metal content by means of the EBID method. Among these ferromagnetic metals, Co attracts the most attention because an exceptional high purity can be obtained under the correct deposition conditions. Here, we present a systematic investigation of the deposition parameters and the characterization of the structure and physical properties of our FEBID cobalt deposits. Utilizing the same dual beam tool, we have also managed to fabricate magnetic nano-wires out of Pt/Co/Pt-multilayers by means of Focused-ion-beam modification and we have studied the corresponding magnetic properties as well. For both types of structures, magnetic properties were characterized by MOKE microscopy. Specifically, we investigated individual nano-scale wires down to diameter sizes of 30 nm [2] as well as magnetic dot-arrays with periods as low as 13 nm. References: [1] R. Lavrijsen et al., Nanotechnology 22, 025302 (2011); Y.M. Lau et al., J. Vac. Sci. Technol A 20, 1295 (2002); A. Fernandez-Pacheco et al., J. Phys.D: Appl. Phys. 42, 055005 (2009); A. Perentes et al., J. Vac. Sci. Technol. B 25, 2228 (2007); [2] E. Nikulina et al., Appl. Phys. Lett. 100, 142401 (2012).