Co/Pd-based synthetic antiferromagnetic multi-stacks for biomedical applications

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Mesoscale magnetic particles (from few nanometers to microns) are a major class of materials with the potential to revolutionize current clinical diagnostic and therapeutic techniques. They are commonly fabricated by bottom-up chemical methods; however, recent studies have demonstrated that top-down approaches based on techniques developed for micro/nano electronics can be used to fabricate monodisperse magnetic micro/nanoparticles with a complex structure and shape that are hard to obtain by means of chemical routes [1,2]. In this work, thin film stacks consisting of multiple repeats of single $[Co/Pd]_N/Ru/[Co/Pd]_N$ units with antiferromagnetic coupling and perpendicular magnetic anisotropy were investigated and exploited as a potential starting material to fabricate free-standing synthetic antiferromagnetic microdisks. For this purpose, films were directly grown on a sacrificial optical resist layer (AZ5214) spinned on a thermally oxidized Si substrate, which would serve to obtain free-standing particles after its dissolution. Furthermore, the film stack is sandwiched between two Au layers to allow further bio-functionalization. The samples fulfill all the key criteria required for biomedical applications, i.e., zero remanence, zero field susceptibility at small fields and sharp switching to saturation, together with the ability to vary the total magnetic moment (by changing the number of repetitions of the multi-stack) without significantly affecting any other magnetic features. Moreover, the samples show a strong perpendicular magnetic anisotropy, which is required for applications relying on the transduction of a mechanical force through the particles under an external magnetic field, such as the mechanical cell disruption, which is nowadays considered as promising alternative to the more investigated magnetic hyperthermia approach for cancer treatment [3]. Preliminary results on microdisks (M = 5, diameter: 2 μm, pitch: 4 μm) obtained from the continuous multistacks by combing electron beam lithography and Ar ion milling are also discussed.

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