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3D magnetic nanostructures grown by focused electron and ion beam induced deposition[1]

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Three-dimensional nanomagnetism is an emerging research area, where magnetic nanostructures extend along the whole space, presenting novel functionalities not limited to the substrate plane. The development of this field could have a revolutionary impact in fields such as electronics, the Internet of Things or bio-applications. In this contribution, I will show our recent work on 3D magnetic nanostructures grown by focused electron and ion beam induced deposition. This 3D nano-printing techniques, based on the local chemical vapor deposition of a gas via the interaction with electrons and ions, makes the fabrication of complex 3D magnetic nanostructures possible. First, I will show how by exploiting different growth regimes, suspended Cobalt nanowires with modulated diameter can be patterned, with potential as domain wall devices. Afterwards, I will show recent results where the synthesis of Iron-Gallium alloys can be exploited in the field of artificial multiferroics. Moreover, we are developing novel methodologies combining physical vapor deposition and 3D nano-printing, creating Permalloy 3D nanostrips with controllable widths and lengths up to a few microns. This approach has been extended to more complex geometries by exploiting advanced simulation growth techniques combining Monte Carlo and continuum model methods. Throughout the talk, I will show the methodology we are following to characterize 3D magnetic nanostructures, by combining magneto-optical Kerr effect, scanning probe microscopy and electron and X-R magnetic imaging, and I will highlight some of the challenges and opportunities when studying these structures.

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