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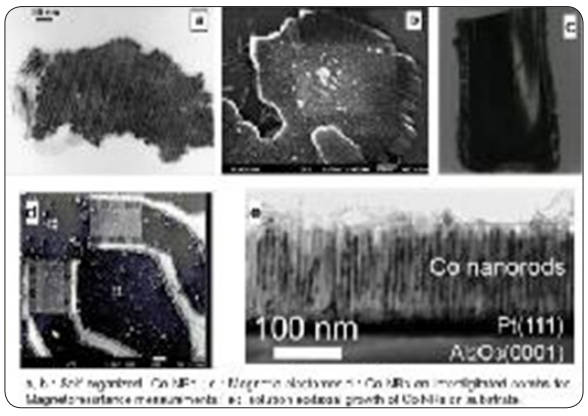
Ferromagnetic single crystalline Co nanorods integration in functional nanostructures

Magnetic nanoparticles are key building blocks for numerous innovative functional materials. Massive production is now possible by using chemical approaches. Some years ago, we presented the solution synthesis of monocrystalline Co nanorods (NRs) by decomposition of a coordination cobalt precursor in the presence of hexadecylamine (HDA) and lauric acid (LA). These NRs spontaneously form well organized super-lattices over limited areas, and their magnetic properties are very interesting with high remanence and high coercive fields. These ferromagnetic NRs (diameter of 5-6 nm) are promising candidates for several innovative applications. Here, we show examples of functional materials made with these building blocks. Hybrid nanocomposites based on magnetic nanoparticles dispersed in liquid crystalline elastomers are expected to show strong magneto-elastic coupling. It may open new applications as actuators, magnetic switches, thanks to their elastic behavior and deformability, combined with their shape memory properties. In this context, we report the synthesis of a novel hybrid ferromagnetic liquid crystalline elastomer. In this material, highly anisotropic Co nanorods are aligned through a cross-linking process performed in the presence of an external magnetic field. The hybrid materials exhibit remarkable magnetoelastic coupling. The nanorods orientation is rotated at room temperature by a weak mechanical stress, leading to a change of more than 50% of the remnant magnetization ratio. Metallic ferromagnetic NPs stabilized by tunable organic tunnel barriers open new opportunities in spintronics. We have integrated these Co NRs on interdigitated combs, while preserving their metallic nature. Magnetotransport measurements display magnetoresistance effect characteristic of spin-dependent tunneling between neighboring nanorods. We demonstrate the feasibility of an all-chemistry approach for room temperature spintronics. Organizing NRs perpendicularly to a flat substrate is an alternative to produce magnetic media. We adapted the classical synthesis conditions to perform chemical solution epitaxy growth directly on substrate. First, a 20 nm layer of Pt (111) is epitaxially grown by sputtering on a α-Al_2O_3 (0001) substrate and then introduced into the fisher reactor containing the Co growth solution of a cobalt precursor and organic ligands (HDA and LA). It led to Co NRs perpendicularly organized side by side on flat substrates and displaying perpendicular anisotropy.



Recent Publications

1. F Dumestre, et al (2003) Unprecedented crystalline super-la<ces of monodisperse cobalt nanorods. Angewandte Chemie-International Edition 42 5213.
2. R P Tan, et al (2018) Magnetoresistance effect in network of ferromagneQc Co nanorods. (In preparaQon).
3. O Riou, et al. (2015) Room-temperature, strain-tunable orientation of magnetization in a hybrid ferromagnetic Co nanorod–liquid crystalline elastomer nanocomposite. Angewandte Chemie-International Edition 127(37):10961–10965.
4. N Liakakos, et al. (2014) Solution epitaxial growth of cobalt nanowires on crystalline substrates for data storage densities beyond 1 Tbit/in2. Nano Letters 14(6):3481–3486.
5. K Soulantica, et al. (2009) Magnetism of single-crystalline Co nanorods. Appl. Phys. Letters 95, 152504.

Biography

M Respaud has his expertise in Nanoscience, Nanotechnology and Nanomagnetism. He has developed an original research on magnetic nano-objects in close collaboration with chemists to grow up new magnetic nano-objects. His aim was to investigate the original magnetic properties arising at the nanometer scale and to tune them by controlling the size, form, and chemical composition. His current objective is to integration of these nano-objects into nano devices.

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