Ferromagnetic, ferroelectric and multiferroic nanostructures. AFM characterisation

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On the one hand, the rapid growth of information storage demand and the continuous trend for miniaturisation require the development of novel miniaturized devices based on nano-objects. On the other hand, the development of organic electronics is seeking for flexible low-cost and light-weight solutions for data storage. This information storage is generally achieved with ferromagnetic materials using a magnetic field to permanently orient the magnetic dipoles and reading their orientations. It can also be achieved by using ferroelectric materials in which information can be stored by orienting the electric dipoles (polarization) with an external electric field. However, the possibility to store and retrieve information using orthogonal write and readout channels offers sturdier storage and access to entirely new device configurations.

In this context, functional nanostructures are developed and synthesized in our laboratory. They are based on magnetic nanowires that could be used for high density magnetic data storage. Ferroelectric field-effect transistors (FeFETs) based on ferroelectric polymers, *e.g.* polyvinylidene fluoride (PVDF) and its copolymers with trifluoroethylene (P(VDF-TrFE)), are also studied for organic memory applications. Finally, by electrochemically depositing ferromagnetic metallic nanowires into the nanopores of a P(VDF-TrFE) template produced by nanoimprint lithography (NIL), hybrid organic/inorganic multiferroic layers are developed. In these layers, the magnetoelectric coupling between the ferroelectric and ferromagnetic phases allows to control the ferroelectric polarisation with an external magnetic field.

The nanometric size of these functional structures requires the use of advanced techniques based on atomic force microscopies to characterise their ferromagnetic, ferroelectric and magnetoelectric properties. In this presentation, it will be shown how in-field magnetic force microscopy (MFM) and piezoresponse force microscopy (PFM) allow these characterisations.