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Material elaboration and nanofabrication techniques for spintronics

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In this lecture, some basic principle of material elaboration and nanofabrication process by lithography techniques will be presented. These are key elements in our research field, in parallel to modeling and measurement techniques. One example could be MRAMs, where one needs to master the elaboration of very complex heterostructures, having some key layers thinner than 1 nm, and to shape them into nanopillars with top and bottom contacts, at challenging technological nodes, before playing with spin transfer torque or magnetic oscillations. Basic research projects will also drastically depend on the material elaboration abilities as well as their shaping into nanodevices or the building of the measurement environment at the nanoscale.

In this view, the lecture shall offer some key elements of the material elaboration and nanofabrication techniques. The general idea is to present their working principle and to provide some process guidelines. We will follow a progressive route, from the material elaboration, mask fabrication, by lithography, followed by transfer techniques and process control through metrology steps.

For the material elaboration, the main technique to be discussed is sputtering deposition, some emphasis on molecular beam epitaxy and other deposition techniques will be also provided. For nanofabrication, electron beam lithography is the method of choice for nanopatterning at the lab scale. Several mask strategies will be presented. In contrast to semi-conductor technology, the transfer techniques using reactive ion etching are much less mature and require usually physical routes for spintronics devices. This will be object of the third part of the lecture. Finally, we will emphasize the importance of controlling the process using several metrology tools.

The lecture outline will be as follow:

1. Material elaboration
2. Lithography
3. Transfer techniques
4. Metrology