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Atomic layer- and chemical vapour- deposition of thin films for spintronic applications

S. Vangelista[1], R. Mantovan[1], A. Lamperti[1], S. Cocco[1], and M. Fanciulli[1,2]
[1]*Laboratorio MDM, IMM-CNR, Via Olivetti 2, 20041 Agrate Brianza (MB), Italy*
[2] *Dipartimento di Scienza dei Materiali, Università di Milano Bicocca, Milano, Italy*
roberto.mantovan@mdm.imm.cnr.it

The possibility of a large exploitation of magnetic tunnel junctions (MTJs) in future devices strongly depends on the ability of growing high quality stacks (i.e. ferromagnetic layers separated by a tunnel barrier with well controlled thickness and interface roughness) on large area substrates. MTJs must fulfil stringent requirements in terms of their morphological and structural properties, excellent conformality and uniformity, low contaminations, and possibly perfect stoichiometry. Atomic layer- and chemical vapour-deposition (ALD, CVD) are standard fabrication processes in semiconductor industry, and they are promising in the view of depositing stacks matching the above-mentioned requirements. However the ALD/CVD methods are still scarcely adopted for MTJs growth, and there are very few reports concerning exclusively MTJs with standard ferromagnetic electrodes and Al_2O_3 tunnel barriers [1,2].

Based on our experience in the use of ALD/CVD for the growth of ferromagnetic thin films [3,4], we propose the combined use of ALD/CVD processes for the synthesis of MTJs stacks. Each layer is deposited keeping low pressure (~10^{-8} mbar) and without any vacuum-breaking, allowing for an *all-in-situ* deposition of the multilayers forming the MTJ (Fig. 1). The low pressure before and during deposition reduces unwanted gas-phase reactions, thus improving films uniformity and conformality. The apparatus is equipped with six, automated controlled, independent bubblers for the precursor injection in the chamber. The substrate is heated for driving the deposition (Fig. 1). We currently target the growth of Co, Fe, and Fe_3O_4 as ferromagnetic electrodes and MgO as a tunnel barrier.

In this contribution we show structural (in Fig. 2 XRR data), morphological, chemical, and magneto-transport results of the first thin films deposited through the developed *all-in-situ* ALD/CVD apparatus.

Part of the research activity here presented is conducted in the framework of the SPAM[3] research project[*].

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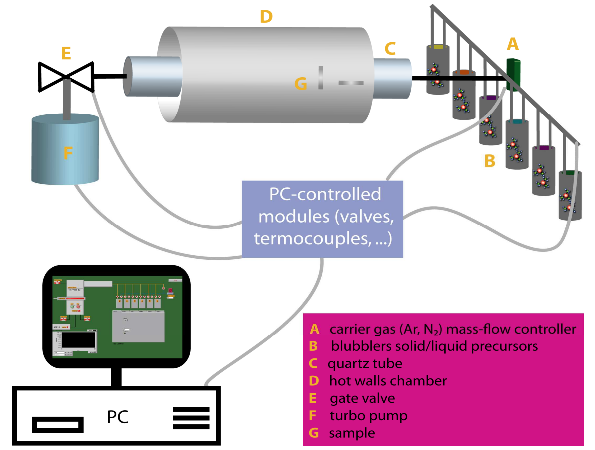

Figure 1. *Schematic picture of the ALD/CVD apparatus for the all-in-situ synthesis of thin films and multilayers for spintronic applications.*

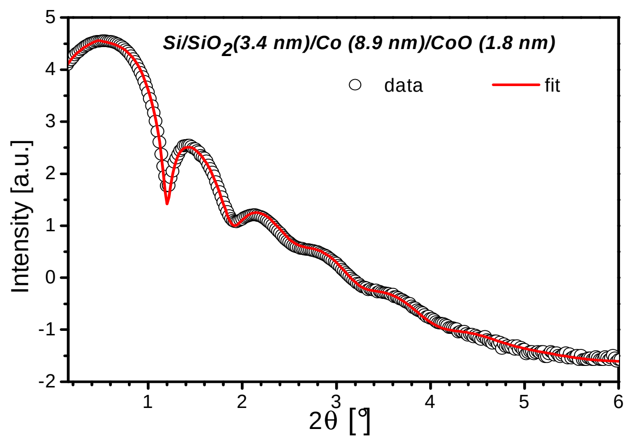

Figure 2. *X Ray Reflectivity (XRR) data and the best fit of a Co layer grown with the ALD/CVD apparatus at* $1.86\cdot10^{-5}$ *mbar from* $Co_2(CO)_8$ *precursor.*

[*] *http://www.mdm.imm.cnr.it/SPAM3*