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INTRODUCTION

Magnetism and its practical applications were one of the main points of attraction since the first mention of the phemomenon in the antique Greece. From that time on, magnetic materials were used in very different ways and nowadays magnetism is omnipresent in our lifes.

In the last decades, the research in magnetism has focused on low-dimensional systems like magnetic particles, clusters, wires or magnetic thin films. The size reduction has a direct impact on the magnetic properties of the systems, like the enhancement of the magnetic moment or the modified ordering temperatures between two magnetic phases of the same material. Different materials with distinct magnetic properties when in direct contact, reveal interesting effects like exchange bias [1] and giant magneto resistance [2, 3].

In particular, the magnetic coupling between layers is of special interest for modern magnetic data-storage applications. The storage media, as well as the read-head sensors, consist of multilayers coupled to each other *via* their interfaces. For example, an antiferromagnetic/ferromagnetic (FM/AFM) interface is utilized in the read-heads of the hard disks to introduce the so-called *unidirectional anisotropy or exchange bias effect*. Furthermore, the existence of a preferred magnetic direction makes possible to distinguish between up and down bits on the hard disk. Although the exchange bias effect is already used in today's devices, its origin is not entirely understood. Beginning with systems like oxygen-coated particles, *e.g.* CoO/Co [1], mono- and polycrystalline ferromagnets deposited on bulk oxides [4], thin-film bilayered and trilayered [5, 6] systems have been studied and plenty of theoretical work [7, 8, 9, 10, 11] has been carried out trying to solve the puzzle of the exchange bias mechanism (EB). Despite this effort, a complete picture of the exchange bias mechanism is not yet evident, since it also involves the understanding of the FM/AFM interface, not only from a structural point of view but also electronically and magnetically. A general theory of the interface can not be completed because of its complexity and numerous ingredients like roughness, strain effects between layers [5], spin rotation of the AFM near the interface [12, 13], or layer thickness [14].

Due to their element and chemical specificities, synchrotron-based techniques like X-ray Absorption Spectroscopy (XAS) with its magnetic circular and linear dichroic counterparts XMCD [15, 16] and XMLD [17], X-ray Photoelectron emission microscopy (XPEEM) and X-ray Resonant Magnetic Scattering (XRMS) are extremely powerful techniques for studying the interfaces. They have provided vital information on the FM/AFM interfaces [4, 18, 19, 20, 21], revealing the presence of AFM spins coupled ferromagnetically to the FM layer at the interface.

In this work, we focus on the properties of ultrathin Fe/CoO bilayers grown onto Ag(001), studied by means of polarization-dependent XAS at the Fe and Co $L_{2,3}$ edges ($2p$ - $3d$ transitions). The aim of this work was to spotlight the interface between the two layers from both the magnetic and chemical points of view. The motivation comes from the lack of studies on epitaxially deposited CoO thin films since the main works were performed on polycrystalline CoO or NiO films, the latter one having a more convenient ordering temperature. To reduce the parameters involved in the problem of interfacial coupling, single-crystalline films are needed. One of the tasks of this project, besides building smooth Fe/CoO films, was the study of the chemical effects at the interface. The second phenomenon to be investigated here was the interfacial uncompensated induced moments in the antiferromagnet, which may play an important role in the magnetic coupling between the magnetic layers.

Part of the work presented here was successfully dedicated to the growth of the layers and to create smooth FM/AFM interfaces. A macroscopic study by means of magneto-optical Kerr effect was performed in order to probe the magnetic properties of the system. Spectroscopy and microscopy experiments were able to depict separately the Fe and the CoO layers from the chemical and the magnetic points of view, thus allowing one to study the interface between these two materials. This study puts in a better light CoO as an interesting AFM system that also exhibits the magnetic coupling to an FM material (in this case Fe) and hopes to be a solid starting point for further theoretical or experimental studies related to this system.

The thesis is structured as follows: Chapter 2 presents a brief introduction to magnetism of thin films, emphasizing the magnetic properties of FM/ AFM bilayers and putting a mark on the most important theoretical models of the exchange bias mechanism. Chapter 3 consists of a record of the experimental techniques and the experimental set-ups used in this work. The results of this study are presented in detail in Chapter 4 in a chronological way, from sample preparation to synchrotron-related experiments. In Chapter 5 a discussion of the main results, comparison, and correlation to related systems and studies in the literature are presented. Finally, Chapter 6 outlines the most important conclusions of the study.