Magnetic proximity effect in Co/Pt multilayer investigated through X-ray resonant magnetic reflectivity

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Transition metals of the 4d and 5d series close to satisfy the Stoner criterion for ferromagnetism \cite{1} can acquire a permanent magnetic moment when they are interfaced with a ferromagnet \cite{2,3,4}. This proximity-induced magnetism rapidly decays away from the ferromagnet/non-magnetic metal (FM/NM) interface and extends for few monolayers \cite{4,5} but has a significant influence on many properties of these systems. Magnetic proximity effect (MPE) is often linked to a strong perpendicular magnetic anisotropy, as is the case in Co/Pt and Co/Pd bilayers and multilayers, attracting considerable interest for possible applications in various fields, including information storage, sensing and biomedicine \cite{5-9}. Relations between MPE and the Dzyaloshinskii-Moriya interaction are strongly debated \cite{10-12} and possible consequences in the development of more efficient spintronic devices were investigated \cite{13}

Refined information on the distribution in depth of the induced magnetic moment have been obtained in X-ray resonant magnetic reflectivity (XRMR) experiments, a powerful photon-in photon-out technique that can study the magnetic properties of a layered sample with sub-nanometer resolution \cite{12,14,15}. In a recent paper \cite{15} reflectivity measurements on a Pd\textsubscript{bottom}/Co/Pd\textsubscript{top} trilayer system demonstrated the presence of a different induced moment between the bottom and top Pd layers. Despite these interesting results, the characterization of the distribution of magnetic moments in real n\textsubscript{m} [Co/NM], multilayers with repeated NM/Co/NM interfaces is still lacking.

In the presented work, combined X-ray magnetic circular dichroism (XMCD) and XMRM measurements are used to study the Co and Pt magnetization depth profile of a complete Pt/Co\textsubscript{bottom}/Pt multilayer. The main goal of this project is to verify if the induced magnetization in the Pt layers is constant across the 2n Pt/Co and Co/Pt interfaces or a dependence along the growth direction is present. A simpler Pt/Co/Pt trilayer was also characterized as a control sample and for comparison with the existing literature. Both samples were grown by sputtering on a thermally oxidized Si substrate with a Ta buffer layer. In-plane and out-of-plane magnetic hysteresis loops were acquired with a vibrating-sample magnetometer. XMCD and XMRM scans were carried out across the Co L\textsubscript{2,3} and the Pt M\textsubscript{1} edge in order to study the magnetic properties of both the elements. The chemical and magnetic depth profiles of the investigated samples obtained from the fitting of the XRMR curves will be presented and discussed.

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