



	Experiment title: XMCD observation of magnetic adatoms on topological insulators Bi_2Se_3 and Bi_2Te_3	Experiment number: HC 688
Beamline:	Date of experiment: from: 12.06.2013 to: 25.06.2013	Date of report: 10.07.2014
Shifts:	Local contact(s): Marcio Soares	<i>Received at ESRF:</i>
Names and affiliations of applicants (* indicates experimentalists): M. Dobrzanski*, M. Wasniowska*, M. Sikora*, A. Kozłowski		

Report:

The purpose of the experiments was to study the magnetic and electronic properties of 3d- adatoms (Fe, Co) adsorbed on topological insulators (TI), i.e. Bi_2Se_3 and Bi_2Te_3 .

In particular, we wanted to:

- Confirm the in-plane and out-of-plane easy axis for Co adatoms on Bi_2Se_3 and Fe adatoms on Bi_2Te_3 , which we observed previously in the experiment performed in ID08.
- Check if the adatoms modify the properties of the underlying surface.

All samples were prepared in the ID08 chamber equipped with magnet. We deposited Co or Fe adatoms either on a Bi_2Se_3 single crystal or on Bi_2Te_3 at 10K after the cleaving process of single crystals.

We select in the following two articles as a summary to show that we could address the two points mentioned above:

Strong out-of-plane magnetic anisotropy of Fe adatoms on Bi_2Te_3 **

T. Eelbo, M. Wasniowska, M. Sikora, M. Dobrzanski, A. Kozłowski, A. Pulkin, G. Autes, I. Miotkowski, O. V. Yazyev, and R. Wiesendanger

The electronic and magnetic properties of individual Fe atoms adsorbed on the surface of the topological insulator $\text{Bi}_2\text{Te}_3(111)$ are investigated. Scanning tunneling microscopy and spectroscopy prove the existence of two distinct types of Fe species, while our first-principles calculations assign them to Fe adatoms in the hcp and fcc hollow sites. The combination of x-ray magnetic circular dichroism measurements and angular dependent magnetization curves reveals out-of-plane anisotropies for both species with anisotropy constants of $K_{\text{fcc}} = (10 \pm 4)$ meV/atom and $K_{\text{hcp}} = (8 \pm 4)$ meV/atom. These values are well in line with the results of calculations.

** Phys. Rev. B (2014) 89, 104424

Co atoms on Bi₂Se₃ revealing a coverage dependent spin reorientation transition [&]

T. Eelbo, M. Sikora, G. Bihlmayer, M. Dobrzanski, A. Kozłowski, I. Miotkowski, and R Wiesendanger

We investigate Co nanostructures on Bi₂Se₃ by means of scanning tunneling microscopy and spectroscopy (STM / STS), x-ray absorption spectroscopy, x-ray magnetic dichroism (XMCD) and calculations using the density functional theory (DFT). In the single adatom regime we find two different adsorption sites by STM. Our calculations reveal these to be the fcc and hcp hollow sites of the substrate. STS shows a pronounced peak for only one species of the Co adatoms indicating different electronic properties of both types. These are explained on the basis of our DFT calculations by different hybridizations with the substrate. Using XMCD we find a coverage dependent spin reorientation transition from easy-plane toward out-of-plane. We suggest clustering to be the predominant cause for this observation.

[&] New Journal of Physics (2013) 15, 113026