X-ray spectroscopic investigations of Heusler alloys

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Within the field of spintronics half-metallic ferromagnetism (HMF) plays a major role. HMF stands for a metallic character in one of the two spin channels while the other spin channel comprises an energy gap at the Fermi level. Thus, the electrical current is carried exclusively by majority-spin states making HMF materials very attractive for the fabrication of spintronic devices. Co-based Heusler alloys Co_2YZ (transition metal Y and main group element Z) have attracted much attention in this field because ab-initio theory has predicted HMF with a band gap in the minority spin channel and a high Curie temperature for many of these compounds. Moreover, in order to overcome the thermally induced suppression of high spin polarization in Heusler alloys a tailoring of the band structure through doping of the ordered alloys has been proposed.

In contrast to the numerous theoretical predictions, only a few experimental verifications of the calculated band structures exist. A direct study of the band gap is however of particular importance for further improvement of these alloys with respect to spintronic applications. Although spin-resolved photoemission or scanning tunnelling spectroscopy can directly probe the spin polarization at a half-metal surface, these methods have no access to the crucial buried interfaces in spintronic devices.

We investigate the electronic properties of epitaxial Heusler films and polycrystalline bulk samples using circular dichroism in X-ray absorption spectroscopy (XMCD)[1,2]. Considering final state electron correlations, we are able to extract the spin-resolved local density of states from XMCD data. We report on results for Co based Heusler alloys with a gap in the minority states and for Mn_2VAl with a band gap in the majority states. Our experimental results corroborate the predicted half-metallic ferromagnetic properties of these alloys and reveal a compositional dependence of the Fermi energy position within the minority band gap.

References

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