Magnetic x-ray techniques applied to MnSb and related half-metallic systems

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An area of condensed matter research which has seen significant progress in the past two decades is the search for a perfectly half-metallic ferromagnet (HMF). Such a material is highly sought after in the now well established field of spintronics, where a material meeting this criterion could be employed to inject a spin polarised current into a semiconductor, enabling the development of transistors and other devices which exploit the electronic spin degree of freedom as well as conventional charge. Some Heusler-structured XMnSb systems (with X = transition metal) have been identified in theory as HMFM's,[1] but experimental corroboration has been less than forthcoming. Here the pnictide MnSb, itself possessing a degree of spin polarisation (Fig. 1), will be investigated in preparation for later work with the trinary systems mentioned above.

Using the technique laid down by C. Utfield *et al*,[2] the Fermi energy spin polarisation for MnSb can be obtained by comparison of experimental magnetic Compton scattering data with *ab-initio* calculations. The Linear Muffin Tin Orbital (LMTO) method allows for the rigid shifting of electronic bands in order to obtain the best agreement with experiment. Density of states calculations then provide spin polarisation as required. Further comparison can be made with the literature when consideration is paid to Fermi-velocity weighting,[3] which is indicative of ballistic or diffusive transport. In addition, comparison of experimental magnetic Compton profiles with nickel standard data will yield the spin moment which, once again, can be checked against calculations to ensure the validity of the approach.

X-ray Magnetic Circular Dichroism (XMCD) is a second x-ray technique which may be employed to probe the electronic and magnetic properties of a potential half-metal. The technique's main use is as an indicator of polarisation, as compellingly demonstrated for K-edge transitions in ferromagnets by G. Schütz *et al*.[4] The application of sum rules[5] to experimental XMCD spectra will yield the orbital moment and the ratio of spin/orbital moments,[6] providing further opportunities for comparison with *ab initio* calculations and accepted results. An XMCD study has been performed on

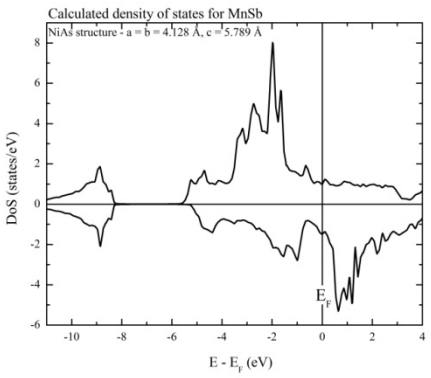

Fig 1. MnSb DOS obtained with SPR-KKR.

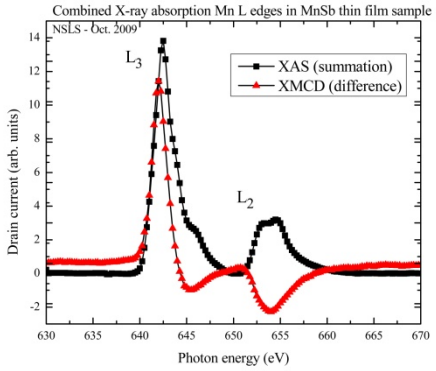

Fig 2. XAS and XMCD Mn L-edges of thin-film MnSb.

thin-film MnSb, prepared by MBE at Warwick, (Fig. 2) and comparison with bulk measurements is desirable.

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