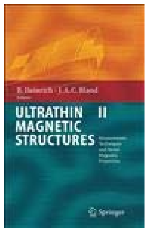

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Magneto-Optical Effects in Ultrathin Magnetic Structures

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Ultrathin Magnetic Structures II
Measurement Techniques and Novel Magnetic Properties

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Bretislav Heinrich and J. Anthony C. Bland

S.D. Bader[3] and J.L. Erskine[4]

(3) Argonne National aboratory, Argonne, IL 60439, USA

(4) Department of Physics, University of Texas, Austin, TX 78712, USA

Without Abstract

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4. Magneto-Optical Effects in Ultrathin Magnetic Structures

S.D. Bader and J.L. Erskine

The magneto-optic Kerr effect has provided an important new means of probing a broad range of thin film magnetic properties. This chapter covers recent developments and new applications of magneto-optical techniques with an emphasis on phenomena encountered in thin film structures. No attempt has been made to include all relevant topics nor to reference all important work in the field. The objective has been to provide a balanced summary of magneto-optic Kerr effect applications that complement topics covered in other chapters of this two volume set on ultrathin magnetic structures.

4.1 Microscopic Basis

Magneto-optical effects in ferromagnetic materials are produced by a combination of the net spin polarization that exists in the ferromagnetic state and the spin–orbit coupling [4.1]. The spin–orbit interaction couples the spin components of the electron wavefunctions to the spatial components which govern the electric dipole matrix elements and optical selection rules.

Manifestations of ferromagnetic behavior observed as changes of polarization and/or intensity when light is reflected from a magnetic material are called magneto-optic Kerr effects. The general property that distinguishes magneto-optic Kerr effects from other magneto-optical effects in solids is that all manifestations of the Kerr effect are proportional to the magnetization $M(T)$ and vanish at temperatures above the Curie temperature T_C.

The magneto-optical response of a magnetic material can be calculated (in principle) in the same manner that the optical response of a non-magnetic material is calculated, the difference being that calculations of the magneto-optical response require carrying out the evaluation of dipole matrix elements to first order in the spin–orbit terms (for both the wavefunctions and the momentum operator) [4.2]. Various regimes [4.1–8] have been used as a basis for calculating the magneto-optical response. In the long-wavelength limit, a Drude-like treatment [4.6] based on the Boltzmann equation has been used. In the visible region [4.5, 6] the optical and magneto-optical response is governed by the electronic structure, and realistic models must be based on conduction band wavefunctions. In the vacuum-UV/X-ray region, where core

B. Heinrich and J.A.C. Bland (Eds.)
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