New mode of domain imaging: Second harmonic generation microscopy (abstract)

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Magnetization induced second harmonic generation (MSHG) is a novel magneto-optical technique that has an enhanced surface/interface sensitivity and demonstrates very large magneto-optical effects.[1] It is described by a generalized nonlinear optical tensor $\chi^{(2)}$ which has different transformation properties as compared to the linear tensor $\chi^{(1)}$. As a consequence, in the same geometry MSHG may be sensitive to other magnetization components than linear magneto-optics. Therefore linear and nonlinear magneto-optics should work best in a combination. Here we report the development of a magneto-optical microscope that is sensitive simultaneously to the linear (Faraday or Kerr) and nonlinear (MSHG) magneto-optical effects. MSHG, on the one hand, is able to visualize some exotic domain structures, e.g., 180° domains in antiferromagnetics and ferroelectrics. On the other hand, because of its interface sensitivity it might help to visualize the magnetic structure at the interface between two different magnetic materials (including metals). Last but not least, the microscope evidently has an enhanced resolution due to the frequency doubling of detected light. First, we apply the microscope to the study of domains in magnetic garnet films, where a considerable difference between Faraday and MSHG images in the *same* configuration is demonstrated. A complicated noncollinear domain structure is straightforwardly derived from the MSHG images. Next, we consider the application of our technique to the magnetic metal surfaces and thin films (in reflection). The utilization of the microscope to correlate the surface/interface morphology with its magnetic properties is discussed. © *1997 American Institute of Physics.* [S0021-8979(97)89508-4]

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[1] H. Wierenga *et al.*, Phys. Rev. Lett. **74**, 1462 (1995); B. Koopmans *et al.*, *ibid.* **74**, 3692 (1995).

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