

Encontro de Outono da SBF 2019 / ID: 656-1

Magneto-optical properties of GdN epitaxial layers

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GdN is a ferromagnetic insulator that offers an interesting opportunity for optically controlled spintronic devices, based on the proximity coupling of few nanometer epitaxial GdN layers to graphene, 2D systems and superconductors. A pre-requisite for such applications is knowledge of the optical band-edge absorption and magnetic circular dichroism of the GdN layer, which as we show here is sensitive to the GdN layer thickness. In this presentation we report on a magneto-optical investigation of GdN epitaxial crystalline layers, of thickness in the range 3.2-350nm, grown on sapphire substrate and capped by 10nm AlN. The band edge optical absorption spectrum was measured in the 0.7-2.5 eV photon energy range, at room temperature and at 6K. The optical absorption is characterized by a smooth step around the bandgap and monotonic increase towards high photon energies. The bandgap at a fixed temperature shows a shift towards increasing energies when the thickness of the GdN layer is reduced. On cooling the sample from room temperature to 6K, the bandgap redshifts for all samples. The observed redshift on cooling correlates with the onset of the ferromagnetic phase below the critical Curie temperature, which was determined from the Faraday rotation as a function of temperature. The magnetic circular dichroism in the ferromagnetic phase was also investigated. The optical control of the magnetic phase was attempted. Work at USP supported by FAPESP (2017/24125-5) and CNPq (401694/2012-7); at MIT by NSF (DMR 1700137), ONR (N00014-16-1-2657), Center for Integrated Quantum Materials (NSF DMR-1231319) and Brazilian agencies CAPES (G. Vilela/POS-DOC-88881.120327 /2016-01), FACEPE and CNPq. Some of the authors have additional addresses\footnote{Author G. D. Galgano is also at Departamento de Química e Física, Universidade Federal do Espírito Santo, Alto Universitário, s/nº - Guararema, Alegre, ES - CEP 29500-000 and author G. L. S. Vilela is also at Escola Politécnica de Pernambuco, Universidade de Pernambuco, Recife 50720-001, Brazil}.