Magnetooptical properties of (Ga,Fe)N layers

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Numerous works on diluted magnetic semiconductors carried out over the last decade have aimed in examining intricate interplay of ferromagnetic and semiconducting properties [1]. Wide band gap semiconductors such as GaN and ZnO doped with magnetic ions are particularly interesting in view of their wide ranging applications. Here we present results of magnetic circular dichroism (MCD) and Magneto-optical Kerr effect (MOKE) measurements in the excitonic spectral region performed on (Ga,Fe)N layers. In contrast to previous magnetooptical studies [2], we focus here on possible magnetoptical signatures of Fe-rich nanocrystals that appear in (Ga,Fe)N films obtained under suitable growth conditions [3].

We compare magnetoptical properties of two layers with similar concentrations of paramagnetic Fe ions (3×10^{19}cm^{-3} and 2×10^{19}cm^{-3}, respectively), one containing Fe-rich nanocrystals, the other not, according to extensive SQUID, XRD, and HRTEM characterization. As found in SQUID measurements, the sample with Fe-rich nanocrystals reveals a ferromagnetic response persisting up to above room temperature for two orientations of the magnetic field in respect to the c-axis. Reflectivity and MOKE measurements are performed in the Faraday configuration with the c-axis parallel to the incident beam in the magnetic field up to 7 T at 2 K. The sample is illuminated by a Xe lamp.

We find that the field dependent magnitudes of MCD and Kerr rotation angle in the excitonic region are well descried by the paramagnetic Brillouin function in both samples. This means that ferromagnetic features, clearly seen in SQUID magnetometry, are not contributing to the magnetooptical response. We conclude that either character of nanocrystal magnetoptical properties or the nanocrystal distribution and density are not optimized to result in sizable magnetoptical phenomena. Instead, the presence on Fe-rich nanocrystals reduces the magnitude of the paramagnetic-like magnetooptical signals. In line with this observation, we find that a large magnetooptical response can be recovered by Ar sputtering of the sample surface, the finding consistent with the location of nanocrystals near the film surface [3].

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