Optical and magneto-optical properties of Bi substituted yttrium iron garnets prepared by metal organic decomposition

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Magnetic garnets attracted considerable attention due to the spintronic effect phenomena such as spin Seebeck effect [1] and spin Hall magneto-resistance [2], or applications in integrated Magneto-Optical (MO) [3] and non-reciprocal photonic devices [4]. Yttrium iron garnets with high bismuth ion concentrations, $Y_{3-x}Bi_xFe_5O_{12}$ (Bi:YIGs) exhibit very strong spin-orbit coupling caused by the presence of Bi and so high MO figure of merit [5]. Several techniques have been used to grow Bi:YIGs films of optical quality. Among them the Metal Organic Decomposition (MOD) appeared to be a very promising method, because it is inexpensive, simple and guarantees high uniform chemical composition and purity combined with chemical stability [6]. Moreover, it is effective technique for the preparation of Bi:YIGs thin films with high Bi content ($x \geq 2$) which is usually rather complicated and possible only with a few techniques.

In this work, we present a systematic study of optical and MO properties of Bi:YIGs thin films with various Bi concentrations (x = 1.5,2,2.5,3) prepared by MOD on $Gd_3Ga_5O_{12}$ (100) substrates. We used MO spectroscopy and spectroscopic ellipsometry. Spectral dependence of complex refraction indexes obtained from ellipsometric measurements revealed increasing optical absorption with increasing Bi concentrations. Faraday and Kerr MO spectra (shown in fig.1) measured in the photon energy range from 1.5 to 5 eV clearly demonstrated that the increasing Bi concentration enhances the spin-orbit coupling and influences the MO effect. Using the MO and ellipsometric experimental data a spectral dependence of complete permittivity tensor was deduced in a wide spectral range. Comparison of obtained results with the results reported on Liquid Phase Epitaxy bulk-like garnets with small Bi concentrations showed a good agreement and confirmed a high quality of investigated films.

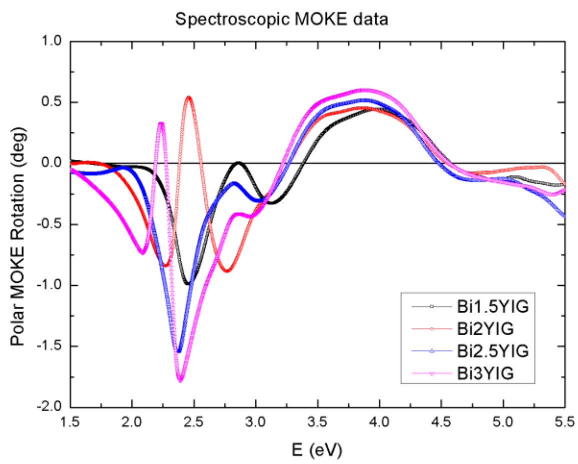

Figure 1: Polar Kerr rotation spectra

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