Ultra-thin high-quality magnetic insulator films

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Due to fundamental limitations, the miniaturization of CMOS devices becomes very difficult, and alternative concepts that allow for higher storage density at low power are required [1]. Spin waves, the elementary low-energy excitations in magnetic systems, exist in the high-frequency regime and are considered a potential technology that can complement the CMOS devices. However, the common magnetic materials, such as Nickel, iron, cobalt, and their alloys used in devices are not ideal for spin-wave propagation due to their high magnetic losses, which translated into shorter propagation lengths. The solution lies in using materials with ultralow damping, such as yttrium iron garnet (YIG) [2-4]. Typically, YIG films are prepared by liquid phase epitaxy (LPE) with a thickness range of tens of microns which is not ideal for applications. Here, we prepared ultra-thin yig films with a thickness down to 30 nm by the pulsed laser deposition technique. We study the static and dynamic properties of these films using a broadband ferromagnetic resonance (FMR) technique where we investigate the effect of the laser energy and the oxygen pressure on the saturation magnetization and the Gilbert damping in these films. We found that a better quality of the films is achieved at higher deposition energy of the laser and under high oxygen pressure. We report ultra-low damping ($\alpha = 2\text{x}10^{-4}$) and Ms = 0.2 T which approaches the recorded values of the bulk YIG films.

References:

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