Change in the Magnetization Dynamics of Pt/YIG/Pt Trilayers with Temperature

Tohoku Univ.[1], ○Satya Prakash Pati[1], and Yasushi Endo[1]
Email: sppati@ecei.tohoku.ac.jp

Yittrium-Iron-Garnet (YIG) films are one of the candidates for spin wave propagation and utilization in spin-wave based devices due to its ultra-low damping at room temperature, electrically insulator. Much attention is also focused on the magnetization dynamics of YIG films for the scientific points of view. Recently, as reported by Haider et.al.[1], the damping of YIG film decreases in the low temperature range, which may be attributed the suppression of thermal scattering of magnon and phonon. Contrarily, other groups reported the damping was enhanced by the spin relaxation via impurities at the low temperature [2], [3]. Thus, the dynamics behaviors of YIG film at the low temperature still remain unclear. Herein, we studied the magnetization dynamics of YIG films in various temperatures between 10 – 300 K by the physical properties measurement system-ferromagnetic resonance(PPMS-FMR) measurement, and discussed their dynamics behaviors in details.

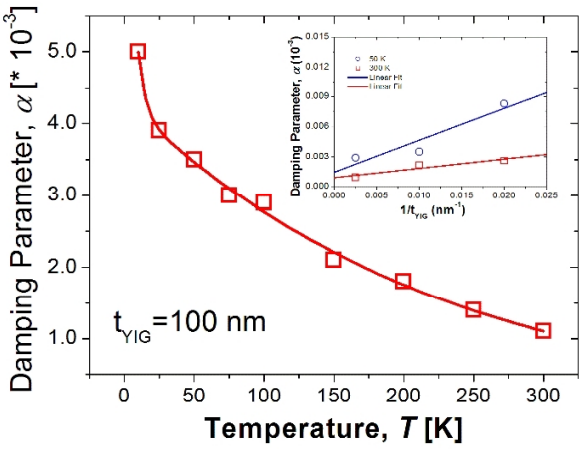

Figure 1: Gilbert damping parameter (α) as a function of temperature for 100 nm thick YIG film. Inset shows the variation of α as a function of inverse YIG thickness measured at temperature 300 K (red squares) and 50 K (blue circles)

In every YIG film, the resonance field was shifted towards low field with the decrease of temperature, while the resonance linewidth broadened as the temperature was varied from 300 K to 10 K. Using these parameters, Gilbert damping (α) was evaluated as a function of temperature. The typical example is shown in Fig, 1. α increased from 1.1×10^{-3} to 5.0×10^{-3} as the temperature was decreased. To clarify the enhancement of α at the low temperature, α measured at 300 K and 50 K are plotted as a function of the inverse of YIG thickness (the inset of Fig 1). The enhancement of α at the low temperature is more pronounced in lower thickness region of YIG, which may be attributed to the magnetic and/or structural inhomogenities at the YIG/Pt interface. The increment of effective inhomogeneous broadening with the decrease of temperature also supports this assumption. On the basis of these results, it is revealed that understanding change in the magnetic behavior of YIG/Pt interface with temperature is very important for the enhancement of the magnetization dynamics in YIG films at the low temperature.

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