Validity of Stoner-Wohlfarth Model for the Nanostructured Cell of Synthetic Ferrimagnets

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Synthetic ferrimagnets which are composed of two magnetic layers sandwiching a non-magnetic layer have attracted a considerable amount of interest as a free layer structure in high density magnetic random access. Synthetic ferrimagnets are expected to have several advantages over conventional single magnetic layer such as small cross-talk effects, coherent magnetization switching and high magnetoresistance ratio. Furthermore, it was reported that synthetic ferrimagnets have additional advantage of superior thermal stability characteristic showing higher value than that of single magnetic layer[1]. Hence, many efforts were made to estimate exact value of thermal stability parameter of synthetic ferrimagnets by measuring thermally assisted switching rate. Equation (1) shows thermally assisted switching rate which is dependant on temperature (T), current density (I) and external magnetic field (H).

$$P = 1 - \exp\left(-f_0 t \exp\left(-E_0(1 - I/I_c)(1 - H/H_c)^2/kT\right)\right) \quad (1)$$

In this equation Stoner-Wohlfarth model[2] is used to express magnetic field-dependant energy barrier of synthetic ferrimagnets. However, no detailed discussion has been presented on the suitability of Stoner-Wohlfarth model for the synthetic ferrimagnets. In this study validity of Stoner-Wohlfarth model for the nanostructured cell of synthetic ferrimagnets is discussed by comparing Stoner-Wohlfarth model with numerically calculated magnetic field dependant energy barrier of synthetic ferrimagnets. Recently proposed analytical/numerical combined method [3] is used to calculate exact total energy of synthetic ferrimagnets which fully accounts Zeeman energy, magnetostatic energy, uniaxial energy and interlayer exchange coupling energy. Synthetic ferrimagnets with various thickness asymmetries and shapes are considered. Energy barrier of synthetic ferrimagnets with small thickness asymmetry showed significant difference from Stoner-Wohlfarth model, while synthetic ferrimagnets with very large thickness asymmetry showed similar result with Stoner-Wohlfarth model.

References

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