CALIFORNIA SCIENCE & ENGINEERING FAIR
2019 PROJECT SUMMARY

Name(s)

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Project Number

S1716

Project Title

Magnetic Damping Study by Broadband Ferromagnetic Resonance

Abstract

Objectives

(a) Broadband (1 GHz to 15 GHz) microwaves are applied to magnetic samples and magnetic resonance occurs when the resonance condition is met; (b) High accuracy is achieved when the magnetic field is modulated and the corresponding response is detected; (c) Yttrium iron garnet (YIG) thin film sample is chosen because of its narrow resonance linewidth; (d) From the resonance peak width at different frequencies, the Gilbert damping parameter is determined; (e) A 5 nanometer thick (BiSb)2Te3 (BST) overlayer is deposited on YIG thin film and the Gilbert damping parameter is determined again and compared.

Methods

(a) Broadband (1 GHz to 15 GHz) microwaves are applied to magnetic samples and magnetic resonance occurs when the resonance condition is met; (b) High accuracy is achieved when the magnetic field is modulated and the corresponding response is detected; (c) Yttrium iron garnet (YIG) thin film sample is chosen because of its narrow resonance linewidth; (d) From the resonance peak width at different frequencies, the Gilbert damping parameter is determined; (e) A 5 nanometer thick (BiSb)2Te3 (BST) overlayer is deposited on YIG thin film and the Gilbert damping parameter is determined again and compared.

Results

At each microwave frequency, the magnetic resonance absorption can be fitted very well by a Lorentzian function. Extracted full-width at half maximum at different microwave frequencies is used to calculate the Gilbert damping parameter of the magnetic material. The 5 nanometer thick BST overlayer is found to have a significant effect on magnetic damping of YIG thin film. The Gilbert damping parameter is found to increase by a factor of four with the addition of the BST overlayer.

Conclusions

The experimental results indicate that strong atomic scale interaction between BST and YIG at the interface plays an important role in enhancing magnetic damping. The results also raise questions for future studies including whether the atomic arrangement in BST is important, how the relative concentration of Bi and Sb atoms in BST affect the results.

Summary Statement

This project is a study of magnetic damping of a magnetic sample influenced by a thin overlayer as a result of strong atomic level interaction.

Help Received

Mother helped me make the poster; father had discussions with me about data fitting. This project used lab equipment at University of California, Riverside under the supervision of Dr. Barsukov and with the help of the students of Dr. Barsukov.