Spin wave detection by CPW with additional electrodes for external field modulation for neuromorphic application

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1. Introduction

A local disturbance in a magnetically ordered body can be propagated through a magnetic material, which is known as spin wave. It can carry information in the form of wave rather than translational motion of electron, rendering the possibility of joul heating free data processing and transmission. The sub 10 nm wavelength of spin wave also paves the way of GHz to THz computation with and shrinking the device size down to 10 nm and smaller. However, the detection of spin wave is challenging. Researcher usually use brillouin light spectroscopy to detect the spin wave signal [1] which is good for basic characterization of spin wave. For practical device application, however, we need to detect and transfer this signal to other subsystem. For this reason, we focused on co-planner waveguide (CPW) for detecting spin wave. Moreover, for implementing the spin wave in data processing, we want to control and modulate it by external means. Among plenty of modulation techniques [2]-[3], we have focused on current based modulation of spin wave considering the integration with existing technology. In this report, we would like to report the spin wave excitation and detection by using CPW and vector network analyzer, and the modulation via magnetic fields using electric current flow.

2. Results and Discussion

Here a PLD grown yittrium iron garnet (YIG) film formed on Gadolonium Galium Garnet (GGG) is used as the magnonic media. YIG is a ferrimagnetic insulator and well known for its lowest reported Gilbert damping constant [4]. The CPW for microwave excitation and detection are fabricated by EB lithography followed by sputtering. One of the complete devices is shown in Fig.1(a) and (b). A vector network analyzer is used to further characterize the spin wave. We kept the distance between exciting and detecting CPW as 20 μm. We use ferromagnetic resonance techniques for exciting and detecting spin wave. Fig.2(a) and (c) represent S_{11} and S_{12} with and without application of magnetic field. From these data we can determine only the spin contribution of S_{11} and S_{12} which are shown in Fig.2(b) and (d). Spin wave frequency is around 3.5 GHz

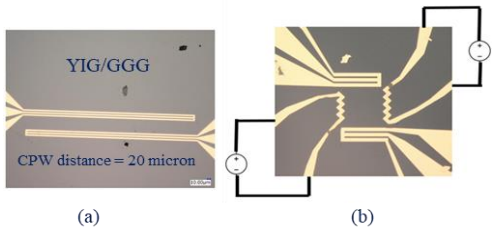

Fig.1(a) CPW (b) CPW with additional electrode based spin wave device

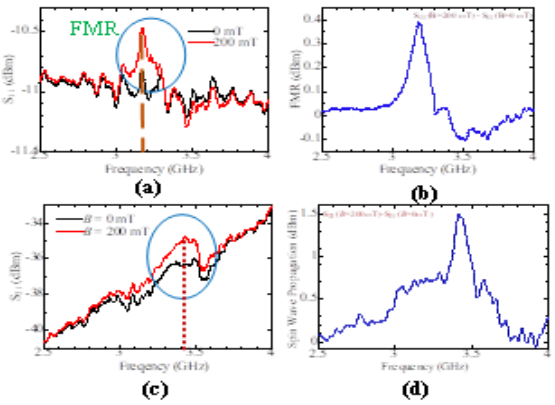

Fig.2(a) –(b) S_{11} (c)-(d) S_{12} for device shown in fig.1(a)

3. Summary

We successfully demonstrated the excitation and detection of spin waves in YIG. Our extended work will be to see the impact of external field modulation by applying current through additional electrodes shown in Fig.1(b)

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