SRRs have lately garnered appreciation in the scientific community for their abilities to constitute such materials, which, unlike their counterparts made up of magnetic elements, show high magnetic energy density over a very confined space and consumes less power. They are made up of nonmagnetic materials and are lightweight options against bulkier ferrite in the high-frequency range (GHz). We are studying the phonon-magnon coupling by investigating the resonance of SRR loaded with YIG ferrite film. The observations are based on experiments as well as simulation results obtained by using RF module of COMSOL5.3a.

RESULTS FOR YIG LOADED SRR

- The FMR appears to be travelling from one end to the other, getting coupled to SRR resonances one by one, gaining strength as they come near to $f_{SR}$. Their magnitude again decreases as they move away. Consider 0.5T, 1T and 1.2T curves in fig.3(a). The coupling between both resonances results in shift in original $f_{SR}$. This happens due to the influence of off-diagonal elements of permeability tensor.

- It was observed that the FMRs occurring at 5th and 6th position follow the Kittel’s equation and then after some extent they become static (see fig. 3(b)). For 1st to 4th position no change has been observed with increase in fields.

- In order to determine the strength of coupling $g|\delta|$, of two resonances, a two state model is adopted which was developed for a SRR in contact with a YIG film. Accordingly, the anti-crossing between the $f_{SR}$ and the FMR can be described by a 2x2 matrix whose solution is as given as:

$$f_{SR} = \frac{|\delta|}{\sqrt{(f_{SR} + f_{IG})^2 + 4\gamma^2}}$$

where YIG resonance is given by Kittel’s equation as shown:

$$f_{IG} = \gamma \sqrt{B_a (B_a + \mu_0 M_{sat})}$$

where $M_{sat}$=Magnetic saturation of ferrite film

$B_a$= Applied bias (T)

$\gamma$=2.88e11(Hz/T)

- Fig. 3(c) shows the plots of the solutions $f_{SR}$ with respect to applied biasing field. The strongest coupling is shown between SRR resonance and pure FMR at $\sim$550G. The $f_{SR}$ is then taken to be that deduced from the fig.3(b), and the solutions are plotted.

CONCLUSION

The magnon-phonon coupling was successfully studied. The maximum coupling strength was found to be 0.4GHz. The work can be further extended for studying the BVSW and MSSW, which were precluded for now. There are many alterations in SRR design that are possible, they also can be studied.

REFERENCES