Effects of Topological Structures in Ribbons of Magnetic Amorphous Alloys

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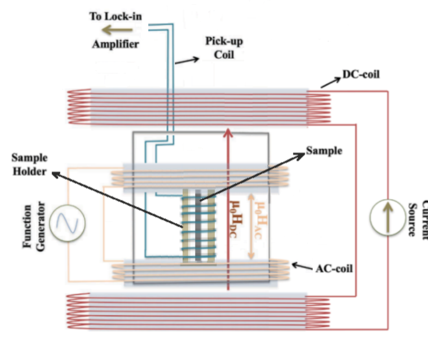
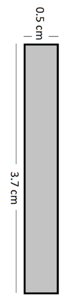
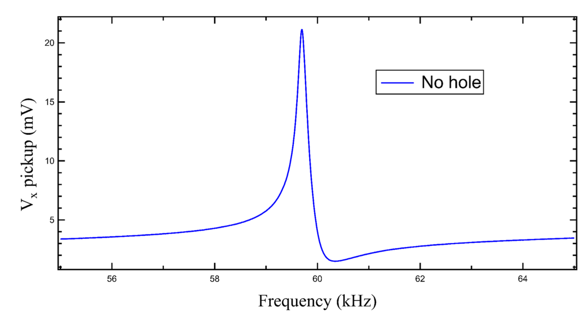
Abstract:

The strong magnetoelastic (ME) coupling in magnetic amorphous alloys (MAA) have been exploited for measuring a variety of physical parameters, such as mass, density, viscosity, humidity, or temperature. When a longitudinal magnetic field is applied, a ribbon of MAA also changes its length. If the magnetic field is then oscillated with variable frequency, a strong induced electromagnetic response (emf) can be detected in a pick-up coil when the oscillating frequency matches the mechanical resonance of the ribbon.Here, we present experimental measurements of the effects of various hole structures on the vibrational modes of MAA ribbons and compare them with COMSOL numerical calculations.

Circuit Design and Typical Response:

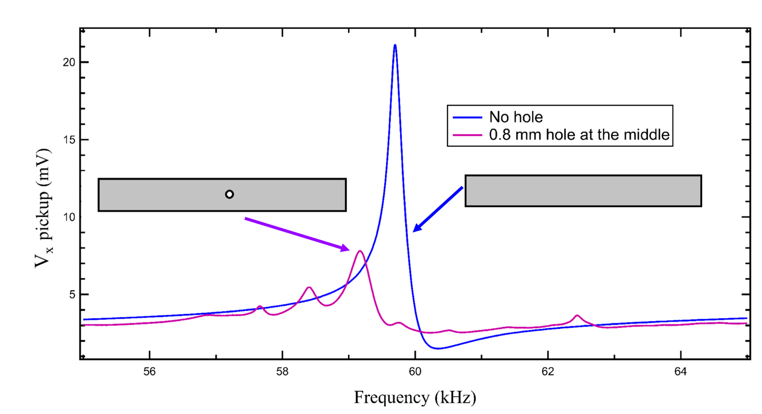
A general circuit design and a response curve of the resonance spectrum measured with lock-in amplifier is presented in the figure to the left and right respectively

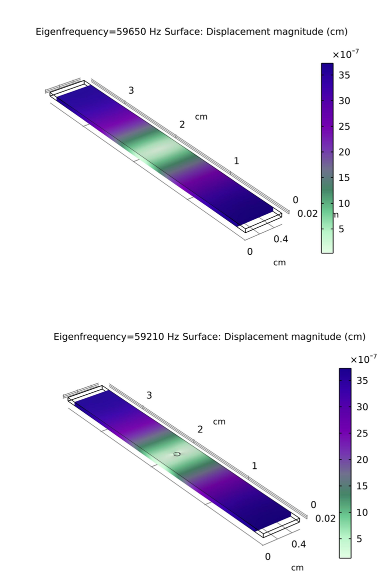




Resonance frequencies are the functions of young modulus and dimensions of the materials: $f_0 = \frac{1}{2L}\sqrt{\frac{E}{\rho}}$

1) Single Defect in the ribbons

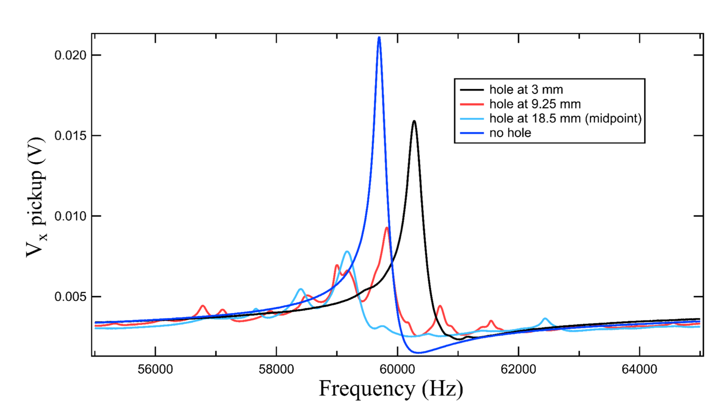
First, we constructed a hole in the middle of the strip and saw that the resonance peaks decrease in amplitude.

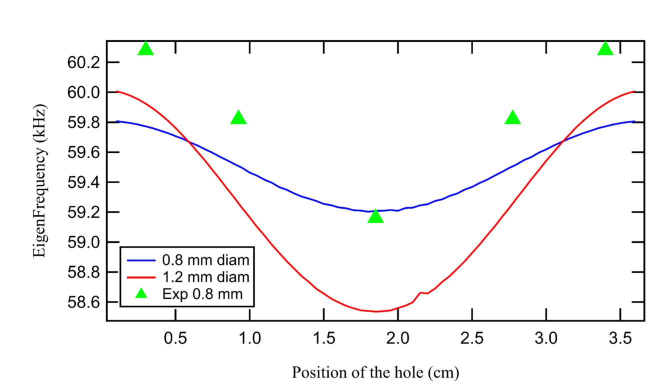




2) Response to position of the defects

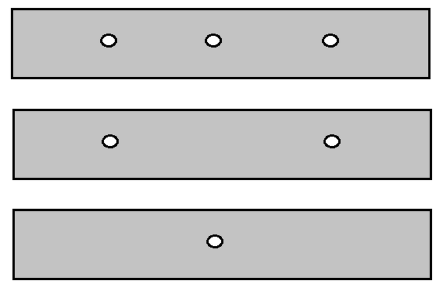
We observe that the resonance frequency can either decrease or increase with the introduction of holes. Generally, the eigenfrequency decreases with increasing proximity to the midpoint. Data from simulation has been supplied to the right to show the comparison.

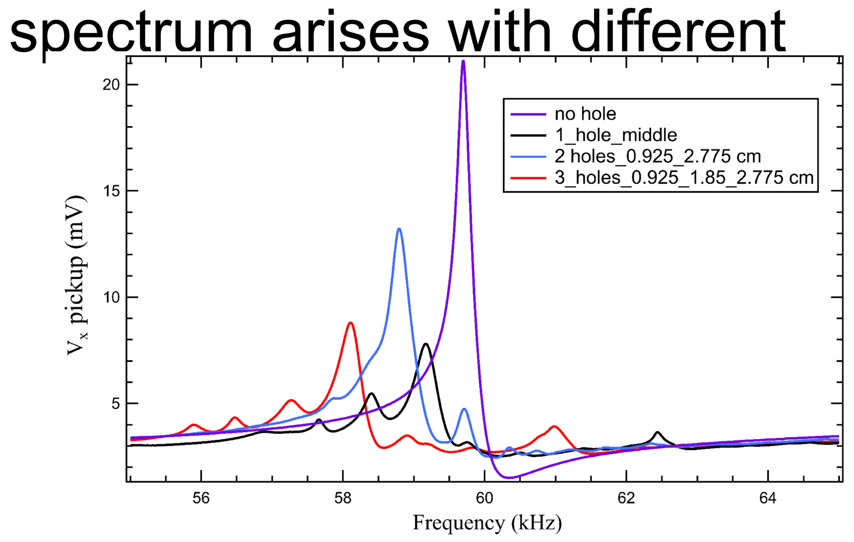




3) Response to the number of defects

Complex resonance spectrum arises with different distribution:





Conclusion:

We present a simple, yet robust platform to study the resonance spectrum with topological defects in the MAA ribbons. While the exact relationship between the resonance spectrum and the topological defects have not been determined, the general trend agrees with the simulation results obtained using COMSOL software.

Future work:

Future work will include a study of complex topological structures to the resonance frequency of these ribbons. We will aim to understand if the peaks are characteristic to the position of the holes in the ribbon and if the topological structure of the materials could be reconstructed given the resonance spectrum of these ribbons.

References:

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