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Tunable Magnetic Anisotropy in Perpendicular Exchange-Coupled CoFeB/(Co/Pt) Films

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Abstract

Development of novel magnetic structures suitable for spintronics applications shows that spintronics materials with strong perpendicular magnetic anisotropy (PMA), such as Co/Pd and Co/Pt multilayers, have been introduced to improve the functional performance of both Spintronics and Spin Transfer Torque (STT) devices (e.g. enhanced thermal stability, scalability and lowered switching speeds and switching current of STT-Magnetoresistive Random Access Memory). Moreover, by coupling magnetic layers with PMA and longitudinal magnetic anisotropy (LMA), added benefits such as a variable magnetization tilt angle and tunable damping have been shown. My project involves obtaining strong perpendicular anisotropy from sputtering Co/Pt films, and understanding the dynamics of full magnetization reversal for future STT application.

Introduction

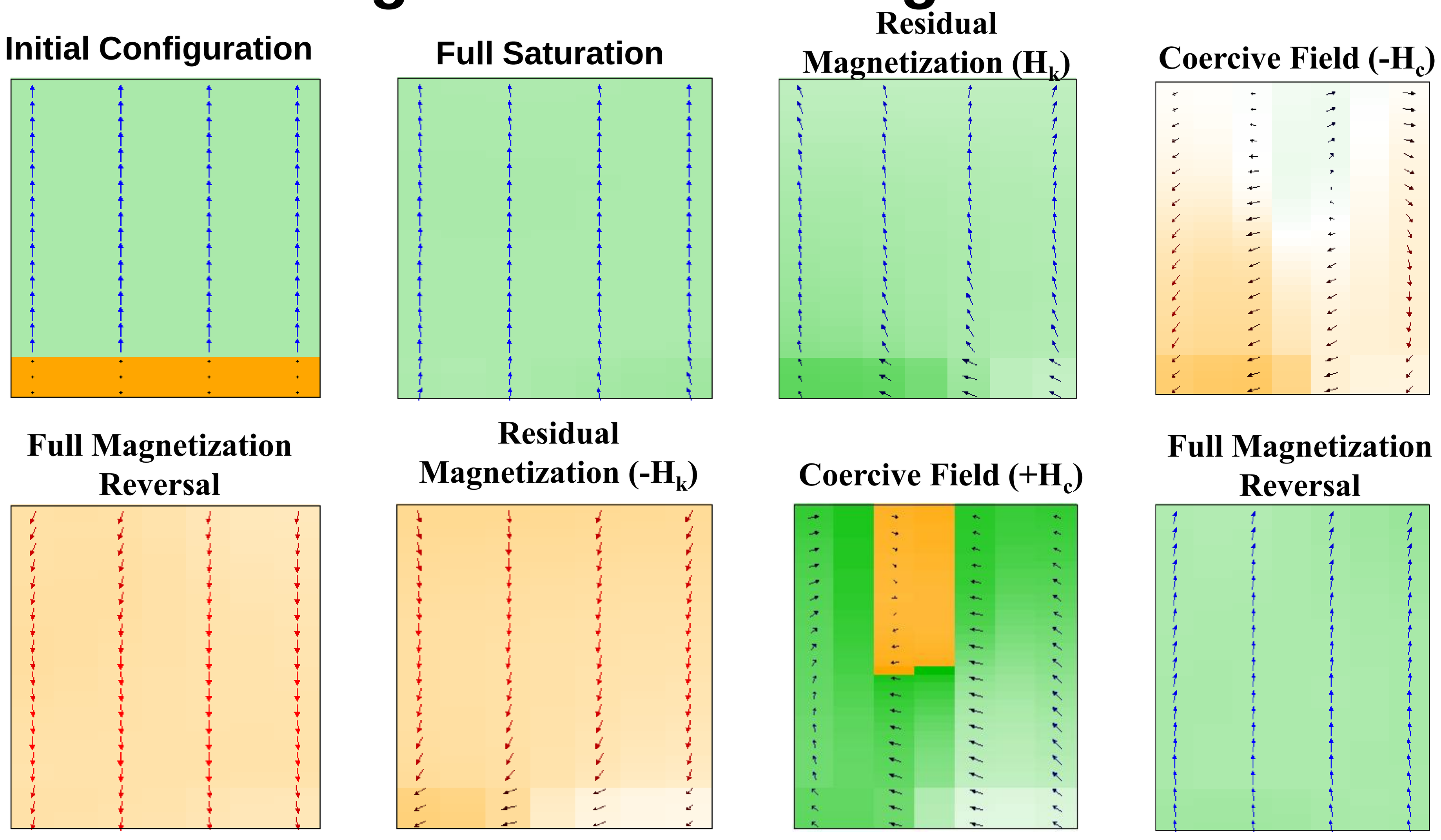
- Spintronics is a branch of technology that utilizes the spins of a certain material's electrons, rather than the electron's charge, to carry and store information by use of either magnetic or electric fields.
  - Spintronics aids in the development of novel magnetic structures. Magnetic Tunnel Junctions (MTJs) are the most common spintronics devices, as they are used in the read heads of most hard disk drives.
- This project involved using the Object Oriented Micro Magnetic Framework (OOMMF) to model certain magnetic multilayers. Using OOMMF could aid in further understanding the dynamics of magnetization switching.

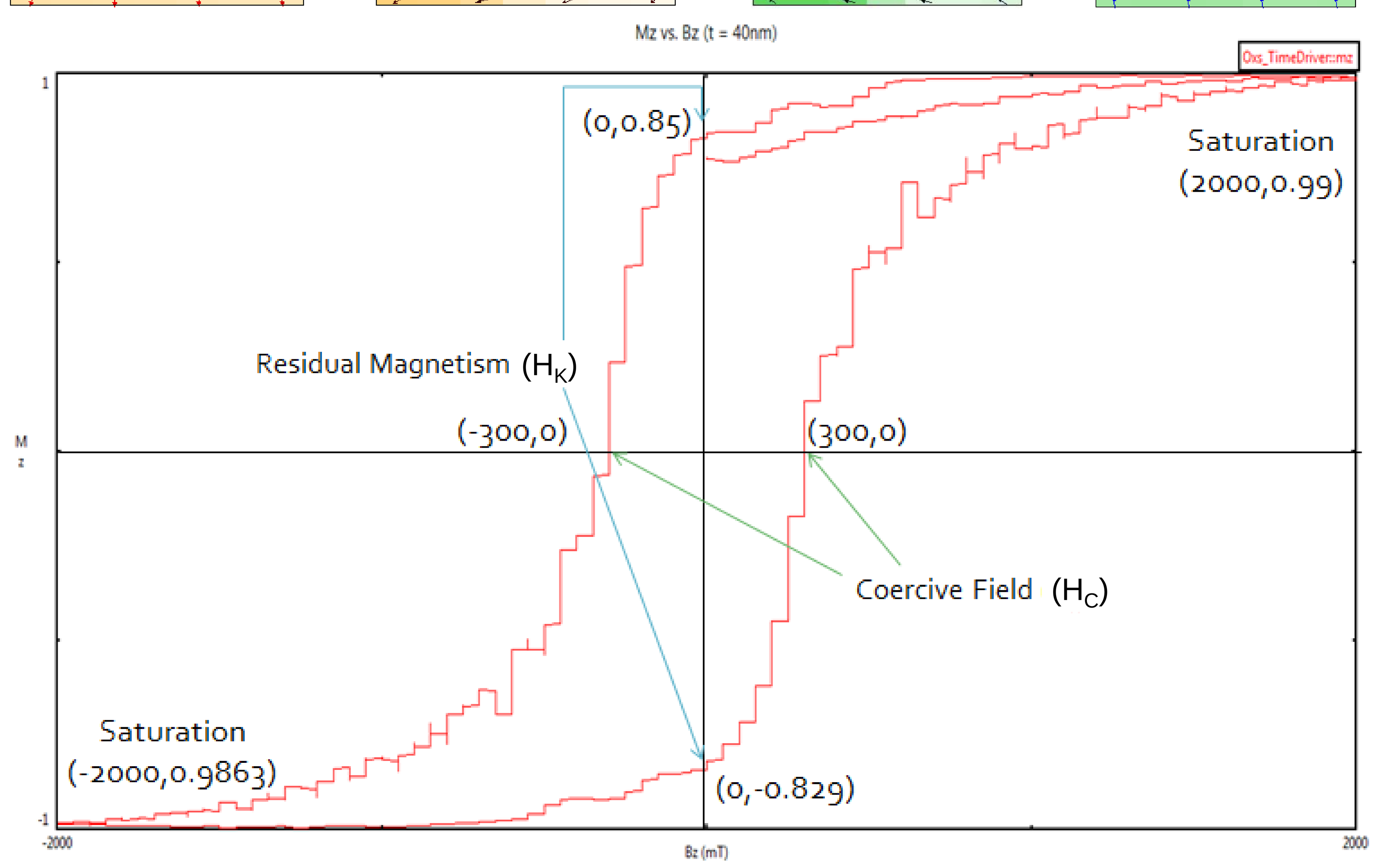
Micromagnetic Modeling

I used OOMMF to model the magnetization reversal of our multilayered film at different stages of the process.

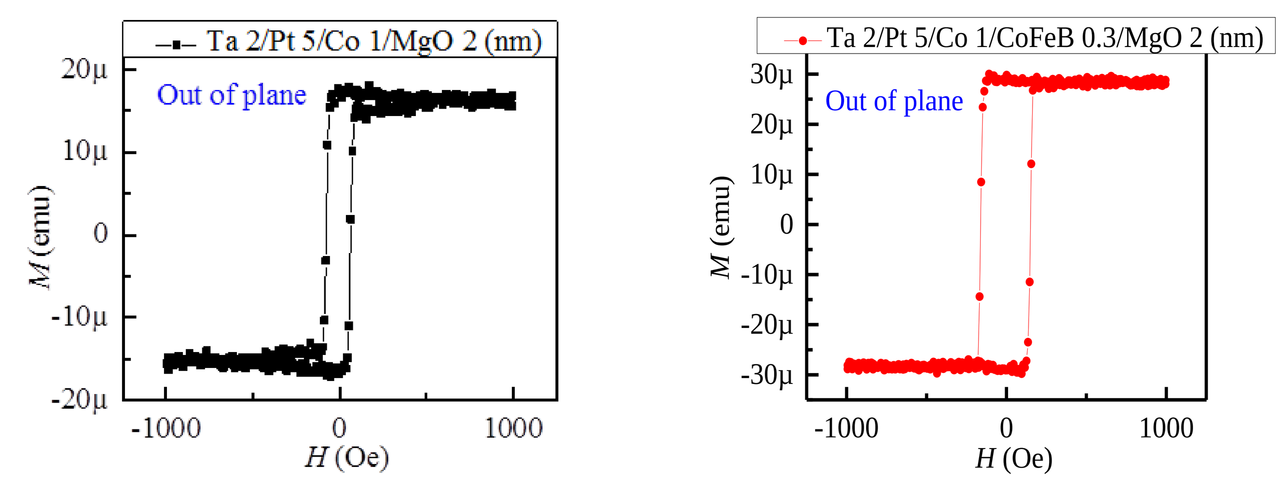
5 nm CoFeB / 35 nm Co/Pt | (5x5x5 nm^3 cell size),
Strong ferromagnetic coupling | Damping (α) = 0.02

Magnetization Configurations

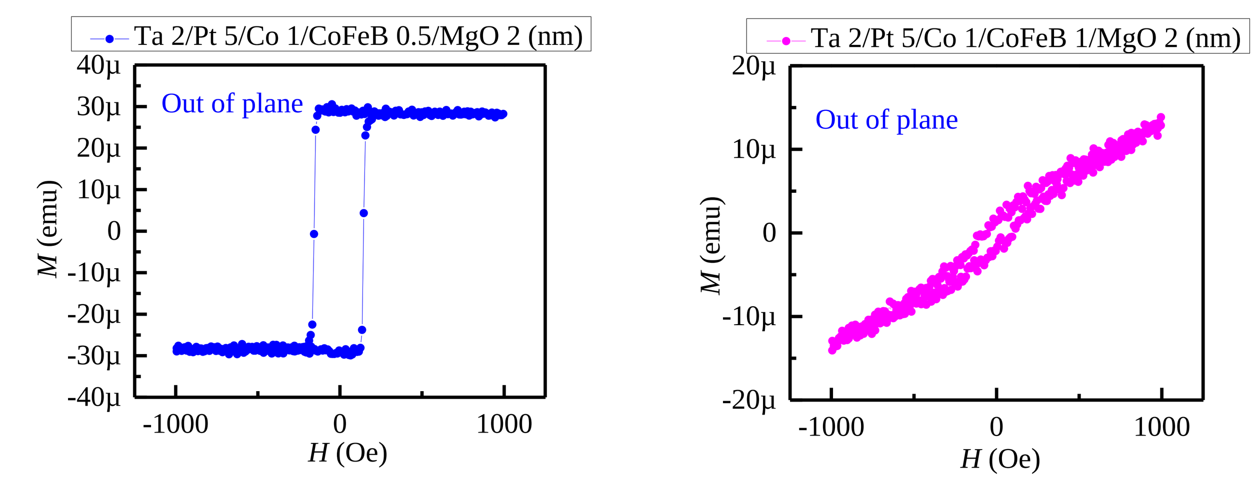




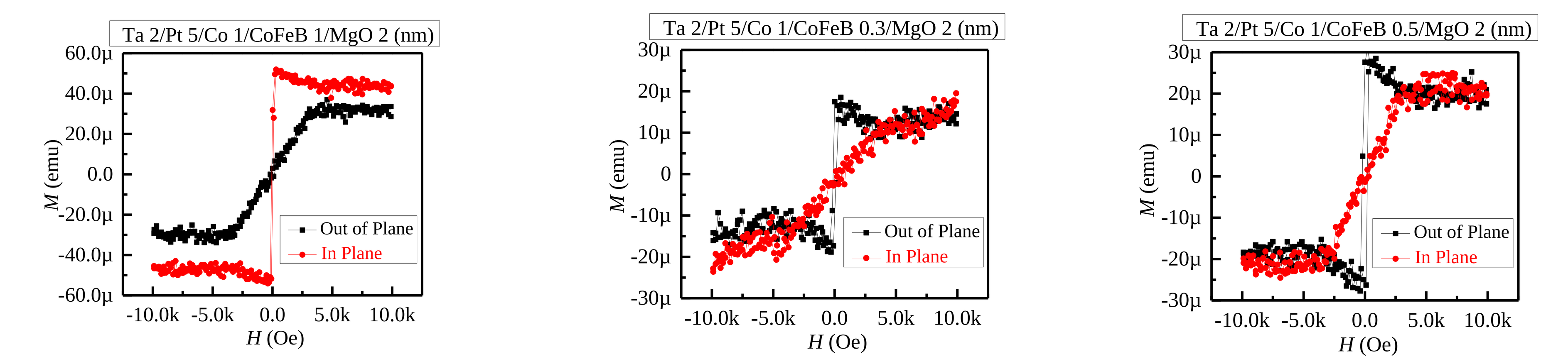
Experiment



A Vibrating Sample Magnetometer (VSM) is used to measure the magnetic moment of a material. Doing so will allow us to see the magnetization reversal.



The graphs below show the magnetic reversal of each film being measured in plane and out of plane.



Results and Discussion

We can see that there is a relationship between the thicknesses of each layer.

We can change ratios between layers to manipulate the anisotropy energy.

Films with small total thicknesses are better.

New Spintronics devices can be built using these films in order to obtain faster magnetic switching, thus having faster reading and writing times.

Next Steps and Future Work

Next steps are to utilize spin transfer torque in order to obtain faster, complete magnetic switching.

Occurs when a spin-polarized current is introduced to a magnetic layer in a Magnetic Tunnel Junction (MTJ).

Causes the magnetic layer to change it's orientation based on the current.

References

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[2] Chikazumi, Sōshin, C. D. Graham, and Sōshin Chikazumi. Physics of Ferromagnetism. 2nd ed. Oxford: Clarendon, 1997. Print.

Acknowledgments

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