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Functional spintronic material Co40Fe40B20 for tunable radio frequency magnetic sensors

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Statement of the Problem: Radio frequency (RF) electronic devices tend to be large and have limited tune ability. Aerospace systems would be more versatile if smaller tunable passive RF electronic devices were available for replacement. The use of spintronic materials such as Co40Fe40B20 can be used to create spin torque transfer nano oscillators (STNO) that are fabricated using complementary metal oxide semiconductor (CMOS) technology and offer current tunable microwave frequency generation. This would allow for on chip fabrication of passive RF electronics, which could easily replace heavier electronic circuits on aircraft to reduce weight. Improvements have been shown to increase when annealing up to 350°C however rapidly declines with increased annealing temperature.

Methodology & Theoretical Orientation: Using RF magnetron sputtering of Co40Fe40B20 onto silicon substrates both heated substrate and post deposition annealing effects can be studied. Examining the crystallinity of thin films throughout thermal treatments by x-ray diffraction (XRD) provide the long-range order of the material. Ferromagnetic resonance (FMR) shows frequency dependent magnetic properties of the material, which change from thermal annealing. Magnetic force microscopy (MFM) shows microscopic magnetic changes at the sample surface.

Conclusion & Significance: Depositing at a substrate temperature of 400 C can reduce FMR peak-to-peak line width from 85 Oe to 54 Oe. Post deposition annealing of substrate heated depositions at 400 C can continue to reduce peak to peak line widths down to 51 Oe until unwanted crystallization of secondary phase takes place. Magnetic force microscopy images show magnetic inclusions from secondary Co7Fe3 forming on the surface. Choosing the appropriate substrate deposition temperature can make device improvements and degradation is a result of secondary magnetic phase material impeding domain wall motion.

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