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STUDY OF INTERFACIAL MAGNETIC ANISOTROPY IN SPINTRONICS: MOS_2 THIN FLAKES ON NANO-THIN FILMS OF $NI_{80}FE_{20}$

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ABSTRACT

The electronic spin is the most important quantum mechanical variable, hence this study focuses on an electron's intrinsic spin properties as well as its magnetic moment. Sensors based on magnons or spin waves are being developed to transport spin current with the least amount of heating effect possible. The demonstration of a nanostructured thin layer of Ni-Fe and MOS_2, based on spintronics and nanotechnology, leads to an examination of the sample's coercivity and magneto-optic Kerr effect. Furthermore, Raman spectroscopy would be used to analyze ferromagnetic resonance line width and damping parameters. As a result, the provided sample will be successfully used in functioning spintronic memory devices.

Keywords: Spintronic Characterization, Magnonic Devices, Electrodeposition, Exfoliation, Gilbert damping parameter

INTRODUCTION

Heavy metals like Pt and Ta have significant spin-orbit coupling, making them suitable for spintronic memory systems. Again, transition metal dichalcogenides (TMDC) could improve spin-orbit coupling. Metal-based spintronics could be a rapidly expanding topic that focuses on unique ways to create and use spin polarization-based current in semiconductor physics. Doping technology in semiconductors can generate dilute or strong ferromagnetism. So, choosing a material for semiconductor spintronics based on its ferromagnetism at ambient temperature is critical. It can be difficult to analyze the effect of photonics and magnetics in semiconductor devices. However, after fixing this condition, spin transistors, memory devices, optical Terahertz-based switches, and highly efficient ultramodern sensors can be developed. Furthermore, the comparison between spin-polarized electron current by electromagnetic waves and thermal gradient process will make it possible to provide more sensitive devices like hard disc drive read head (HDD) and magnetic sensors that can be used in magnetoencephalography to detect and map images of the brain and artificial neurons. [1-4]

Quantum dots can be created by quantizing electron transport in all directions and confining that conducting electron within nanometre distances, resulting in a spin-polarized laser with a spin polarisation of 30% at ambient temperature in a specified magnetic field. As a re be investigated. Spintronic sensors are particularly useful in real-world IoT devices for tasks such as transmission and distribution line monitoring, current sensing, and many types of detectors because of their excellent measuring capabilities, small size, and low cost. Spintronic sensors are once again relevant for spectral analysis in radio transmission systems thanks to IoT technologies. So, the spin degree of freedom contributes to the popularity of spintronic sensors based on current sensitivity, and it may be employed in the process of digital filtering of the Fourier transform and Gaussian filter to eliminate noise in the signal. In this research, the interfacial magnetic anisotropy is explored by the implementation of MOS2 thin flakes on nano-thin films of Ni80Fe20.

METHODOLOGY & RESULT

In this example, the electrodeposition approach is utilized to fabricate magnetic films, which are then characterized using Raman spectroscopy, indicating the successful incorporation of MOS2 thin flakes in the sample magnetic thin film. So, the entire process may be viewed as a multi-fabrication for creating a heterostructure of 2D ferromagnetic layers with high functionality based on high spin-orbit coupling.

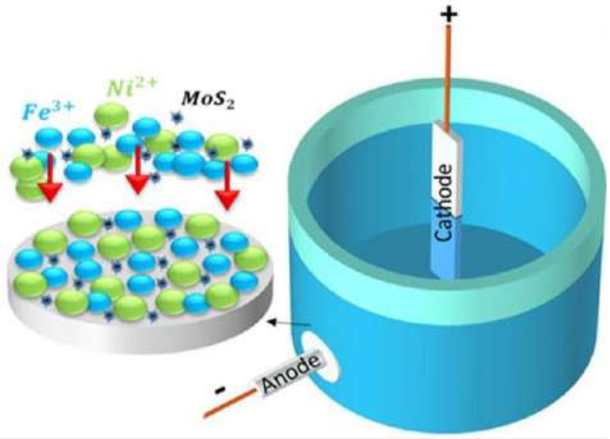

Fig-1: Electrodeposition of the Sample

The $Ni_{80}Fe_{20}$ nanostructure layer is created by combining 0.5 M $NiSO_{4.6}H_2O$, 0.05 M $FeSO_{4.7}$ H_2O, and $0.5H_3BO_3$ in distilled water.

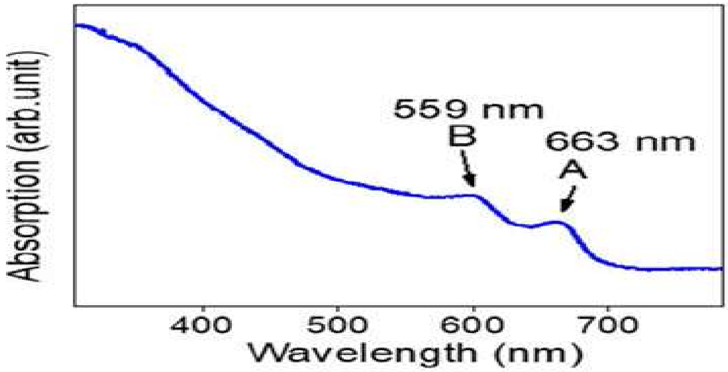

Fig-2: UV-visible spectroscopy of exfoliated MOS_2

After MOS_2 exfoliation, the sample was coupled with it on a Si substrate measuring 1.5x1.5 cm2.

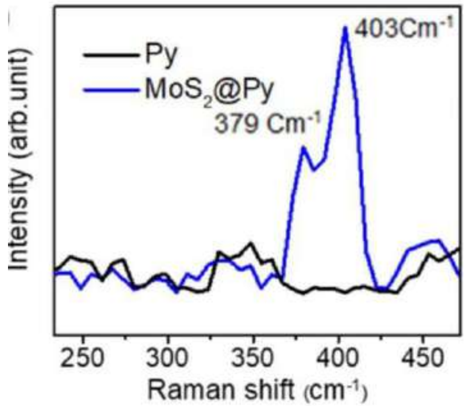

Fig-3: Raman Spectroscopy of the sample.

Finally, the sample is stored in the electrodeposition cell to protect it from further surface oxidation, and then At room temperature, the electrodeposition process lasts 135 seconds. Atomic force microscopy would be used to examine the sample's surface topography [8-9]. Finally, Figure 1 depicts the electrodeposition of the sample.

The UV-visible spectrum is utilized to determine the properties of the water-based exfoliated MoS_2. As illustrated in Figure -2 [9], the peaks of the curve at 559 nm and 663 nm represent the properties of MoS_2 dispersion. When the layer electrodeposition was complete, we noticed that the MoS_2 flakes were encrusted with Ni80Fe20. That is, Raman peaks signify the existence of MoS_2 flakes in the sample's electrodeposition-generated layers, as shown in Figure 3 [9]. α represents the Gilbert damping parameter. The MOKE signal for the sample increases with the fast-increasing value of the saturation magnetization (Ms). Whereas a drop in the Ms value shows that the sample MoS2 is nonmagnetic.

Parameters	**$Ni_{80}Fe_{20}$**	**NiFe-MOS_2**
α	0.02	0.025
M_s (Oe)	10,450	9398
γ	0.003	0.003
ΔH_0 (Oe)	115	232
H_k (Oe)	0	0

Table -1: Calculation of different parameters through FMR

The gyromagnetic ratio (γ) remains constant, whereas the inhomogeneous widening is denoted by ΔH0. We also get a negligible or zero uniaxial anisotropy Hk. In this way, FMR data indicates the effect of MoS_2 on the dynamics of $Ni_{80}Fe_{20}$ magnetization at a given frequency.

CONCLUSION

The electrodeposition method is a more effective and successful method for incorporating MOS_2 into the $Ni_{80}Fe_{20}$ structure. Whereas the temperature and time of the sample in the electrodeposition cell are critical for preparing the proper sample. Magnetic coercivity, as determined by the Gilbert damping value, indicates that MOS2 and magnetic material are properly bonded. Thus, the sample's stronger magnetic coercivity demonstrates that the electrodeposition method outperforms another method for heavy magnetic materials. Again, a threefold increase in the light cavity in the MOKE signal demonstrates the possibility of producing high-quality MOKE sensors and magnonic devices using heavy ferromagnetic materials.

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