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研究プロジェクト名：　Current-induced switching of antiferromagnetic metallic heterostructures

概要： We aim to demonstrate electrical current-induced switching of Mn-based antiferromagnetic metallic heterostructure. The underlying factors (for ex. antiferromagnetic structure, torques arising from current, domain-wall motion, etc.) governing switching characteristics will be elucidated. Theoretical models, supplemented by experimental results, will be developed for understanding of switching phenomenon.

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期待される研究成果：

The results obtained from this research will unveil new directions in the field of antiferromagnetic spintronics. The demonstration of electrical switching in metallic structure is first of its kind within the family of antiferromagnets. The proposed experimental and theoretical investigations will provide deep understanding of magnetization dynamics and spin-dependent transport phenomena in antiferromagnetic structures.

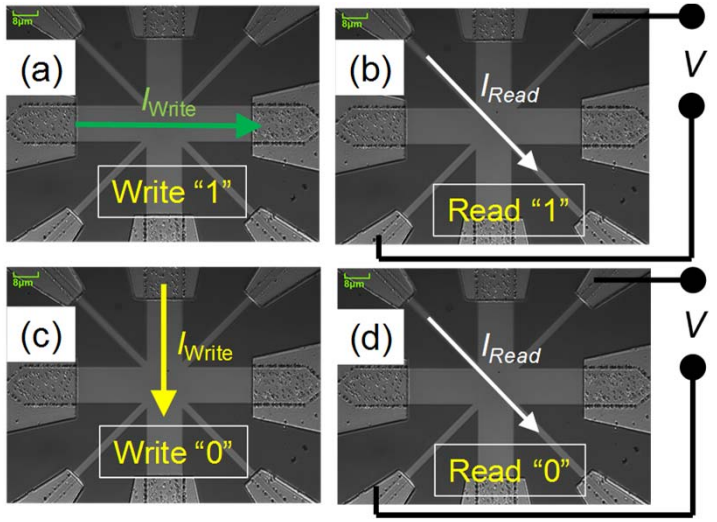

Figure: Microscope image of the proposed device structure. (a)-(b) shows electrical writing and reading of state “1” while (c)-(d) shows writing and reading of state “0”.

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概要： The capability to *write* and *read* information using antiferromagnets (AFMs) are crucial for development of AFM-based spintronic device architectures. Room temperature Mn-based collinear metallic AFMs is one of the potential candidates owing to large magnetic anisotropy and high thermal stability which meets prerequisite conditions for antiferromagnetic memory devices. Demonstration of *reading* and *writing* of this class of AFMs and the understanding of the underlying physics unveils new directions in the field of antiferromagnetic spintronics.

研究成果（実施状況）：

Using an AFM/non-magnet PtMn/Pt heterostructure, we have demonstrated:

(1) Spin-Hall magnetoresistive effects in PtMn/Pt serving as a possible route for reading of the antiferromagnetic resistive states. [1]

(2) SOT-induced manipulation of AFM/NM PtMn/Pt heterostructure. Bi-stable resistive modulation under orthogonal current pulse application has been achieved down to μs regime. Comparison of the electrical measurements with imaging techniques and theoretical models indicates a 90° rotation of AFM PtMn by spin-current injection from Pt. [2]

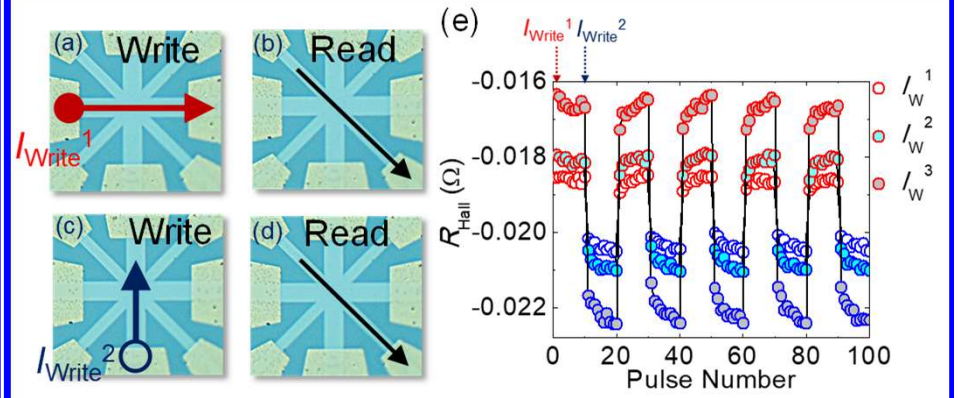

Figure: Schematic of writing of an AFM metallic heterostructure and demonstration of writing. (a)-(b) shows schematic of writing and reading of state “1” while (c)-(d) shows writing and reading of state “0”. (e) shows the experimental results of writing of PtMn/Pt heterostructure under the application of current pulses of 500 ms duration and amplitudes I_W^1, I_W^2 and I_W^3 ($I_W^3 > I_W^2 > I_W^1$).

主要発表論文等： [1] S. DuttaGupta *et al.*, Appl. Phys. Lett. 113, 202404 (2018).

[2] S. DuttaGupta *et al.*, *Manuscript under prep.*