2020「中技社科技獎學金」

2020 CTCI Foundation Science and Technology Scholarship

研究獎學金

Research Scholarship

National Taiwan University
Department of Materials science & engineering

磁性異質結構中自旋軌道矩之研究

The Spin-Orbit Torque in Magnetic heterostructure

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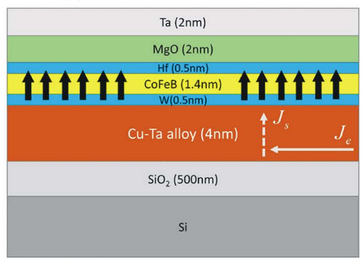
研究重點

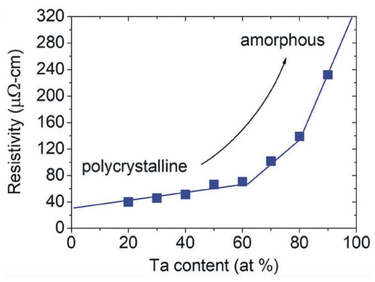
As technology development, the requirement for storage has increased rapidly. The conventional memory device is no longer afford the growth speed. Magnetic random access memory (MRAM) has become the potential candidate for the next generation memory device. The spin-orbit torque (SOT) MRAM is advantageous for its low power consumption, higher storage density, faster speed, and non-volatile properties. Based on the design of SOT MRAM, the spin torque source material generates the spin current to manipulate the magnetization in the adjacent ferromagnetic layer. Therefore, reaching the large spin-torque efficiency becomes an important task for the SOT MRAM. Previous reports show that the 5d transition metals possess large SOTs, like Ta, W, and Pt. However, the spin torque efficiencies in these materials range from 0.10-0.3 which are not sufficient to afford the requirement. On the other hand, to achieve higher storage density, perpendicular magnetic anisotropy (PMA) is necessary. Nevertheless, the PMA SOT device requires an external in-plane field to achieve the current-induced SOT switching, which is a great challenge for application. Hence, achieving the field-free SOT switching is another task to be solved as well. In my study, the spin torque efficiency is tunable through controlling the resistivity of Ta alloy. The spin torque efficiency in the Ta alloy can be enhanced from 8% (pure Ta) to 15%. Also, the field-free SOT switching is achieving by engineering the structural property of the spin torque source layer.

研究成果

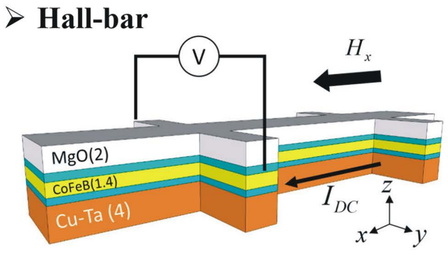
Tunable Spin-Orbit Torque in Ta Alloy

➢ Magnetic heterostructures & Resistivity

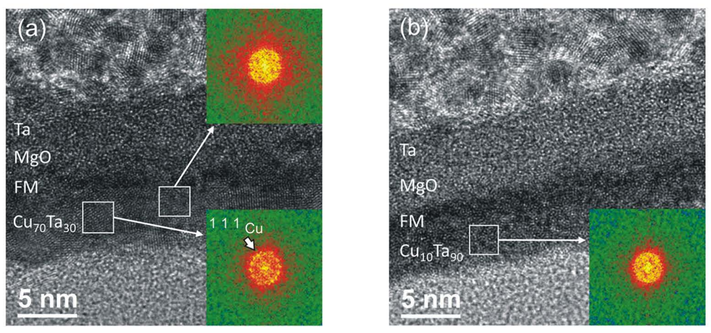




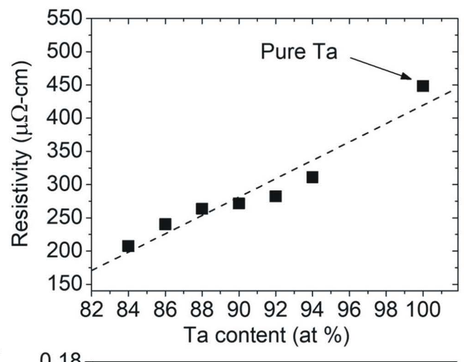
➢ Hall-bar



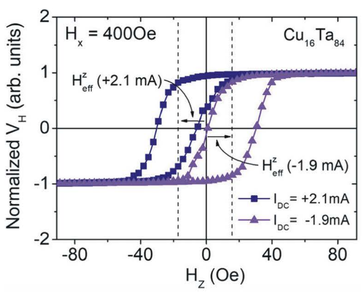
➢ TEM images

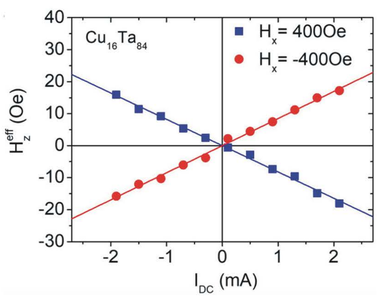


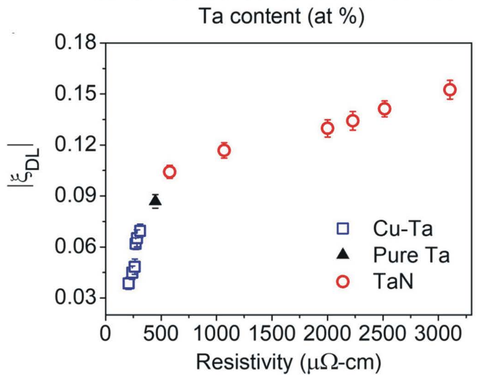
➢ Results



➢ Hysteresis loop shift measurement

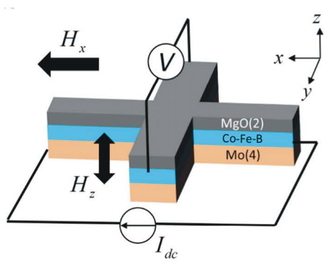




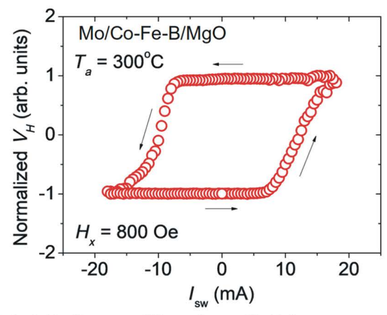


Field-Free SOT Switching in Mo-based Device

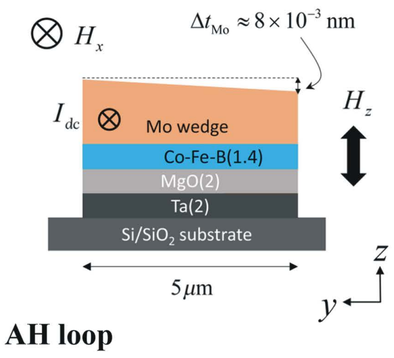
➢ Normal structure



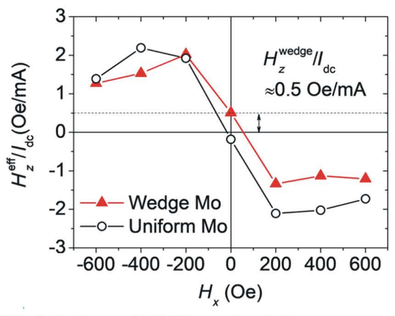
➢ Current-induced SOT switching



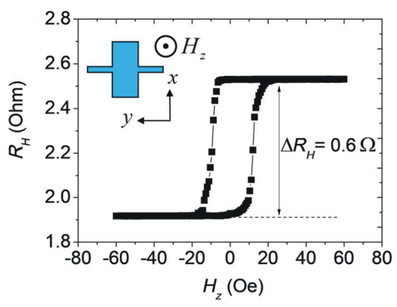
➢ Reversed structure



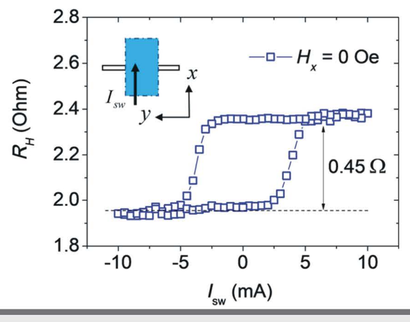
➢ Field-free effective field



➢ AH loop



➢ Field-free SOT switching



研究生活與心得

一開始在碩士班就讀時，並沒有繼續念博士班的想法。而隨著對研究領域的認識及了解，激發對實驗更大的熱誠。在研究的路上，常常會遇到許多困難及阻礙。但是在努力克服並解決問題的過程，學習到非常多的經驗，也成長許多。除了感謝教授的指導、實驗室同學的幫忙外，也很感謝中技社提供獎學金給選擇在台灣攻讀博士學位的學生。這份獎學金不只是實質上的幫助，更是激勵我們秉持原有的熱情，繼續為更好的研究努力。

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