Twist-angle controlled spin-valve operations with all van der Waals magnetic tunnel junctions

Suyong Jung[1]
Keun-Hong Min[1,2], Yong-Sung Kim[1], Jonghwa Eom[2], Jun Sung Kim[3]

[1]*Interdisciplinary Materials Measurement Institute, Korea Research Institute of Standards and Science, Daejeon, Korea*
[2]*Department of Physics and Astronomy, Sejong University, Seoul, Korea*
[3]*Department of Physics, Pohang University of Science and Technology, Pohang, Korea*
syjung@kriss.re.kr

Two-dimensional magnetic materials and their heterostructures with atomically clean van der Waals interfaces provide an ideal experimental platform for investigating spintronic device operations. Twistronics, a research field that exploits the misalignment angles of van der Waals heterostructures with 2D single-crystalline layered materials, has recently gained significant attention. However, the experimental demonstration of 'spin twistronics' employing the versatility of twist angles with 2D magnets has not yet been realized. Here, we present the twist-angle dependent spin-valve operations with all van der Waals-assembled vertical magnetic tunnel junctions made of the 2D metallic ferromagnet Fe_3GeTe_2 (FGT) and the tunnel insulator hexagonal boron nitride (hBN). Our results demonstrate that the vertical spin-dependent charge transport of the FGT–hBN–FGT heterostructures is highly sensitive to the twist angles and the relative spin configurations of the 2D metallic ferromagnets. We observe a tunnelling magnetoresistance ratio up to ~400% for the FGT–hBN–FGT spin valve with a ~2° twist angle, which decreases continuously to ~100% and lower as the misalignment angle increases up to 30°. The experimental realization of twist-angle-dependent spin-valve operations presents a promising direction for expanding the spintronic device capabilities with low-dimensional van der Waals magnets.

Figures

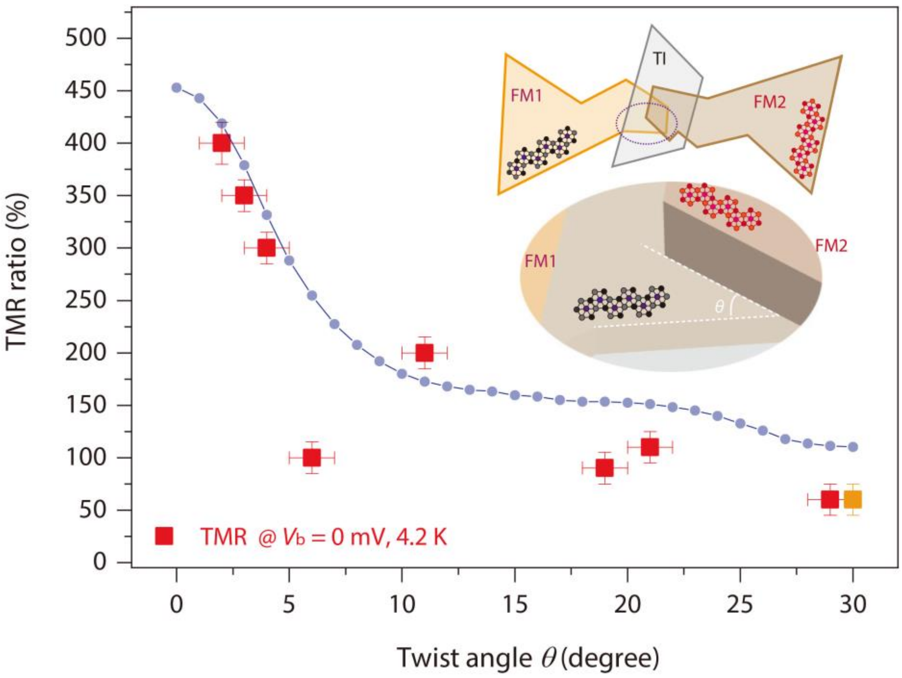

Figure 1: Twist-angle dependent TMR ratio variation from FGT–hBN–FGT magnetic tunnel junctions