Uniaxial magnetic anisotropy in epitaxial Fe/MgO layers on InAs(001)

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An injection of spin polarized electrons across ferromagnetic metal (FM)/semiconductor (SC) contacts is known to be inefficient due to the impedance mismatch between FM and SC. This problem can be solved by inserting a tunneling barrier such as MgO between FM and SC. In addition, InAs is of particular interest in spin-electronic device applications due to a high electron mobility and strong spin-orbit coupling. Although the lattice mismatch between MgO and InAs is quite substantial (～4.2%), Kim *et al*. demonstrated an epitaxial growth of Fe/MgO/InAs(001) and confirmed a two-dimensional growth of the Fe layer[1], which is known to be essential to the efficient spin injection. However, a microstructural analysis was mainly carried out in the previous study with the lack of clear understanding of the magnetic properties. The investigation of magnetic properties of the Fe/MgO/InAs system is essential to further manipulate the injected spin polarization. In this study, we mainly report on the magnetic anisotropy in a fully epitaxial Fe (7 nm)/MgO (4 nm)/InAs(001) system. A clear four-fold anisotropy resulted from magnetocrystalline anisotropy is shown in the in-plane hysteresis loops. However, these in-plane results are not suitable to extract magnetic parameters, because magnetization under in-plane fields occurs mainly by domain wall motion. Therefore, an out-of-plane hysteresis loop is also measured and compared with theoretically calculated result based on the single domain model, where both magnetocrystalline anisotropy and uniaxial anisotropy are considered[2]. The agreement is reasonably good, as shown in Fig. 1, confirming the existence of uniaxial magnetic anisotropy. The direction of the uniaxial anisotropy is tilted at 45° from the out-of-plane direction. The formation of the uniaxial anisotropy is probably due to strain or interface-related effects, although the precise reason is not clearly understood at the moment.

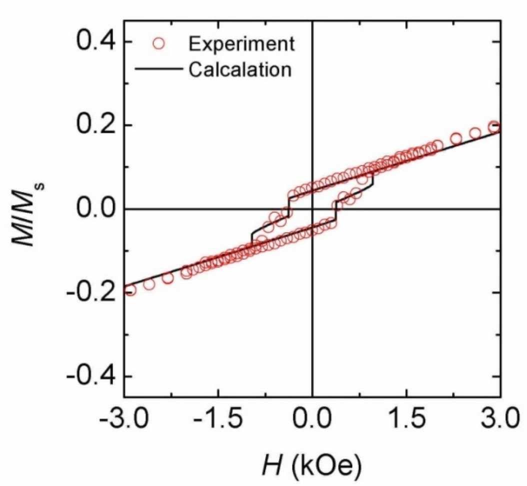

Fig. 1. Experimental and calculated results for the normalized out-of-plane hysteresis loop.

References

[1] K. H. Kim *et al*., Cryst. Growth Des. **11**, 2889 (2011).
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