

Enhanced spin contrast detection by spin-polarized scanning tunneling microscopy of antiferromagnetic Mn/Fe(100) films

Puneet Mishra, Takashi Uchihashi, and Tomonobu Nakayama

International Center for Materials Nanoarchitectonics, National Institute for Materials Science, 1-1 Namiki, Tsukuba, Ibaraki 305-0044, Japan
MISHRA.Puneet@nims.go.jp

Spin-polarized scanning tunneling microscopy/spectroscopy (SP-STM/S) is a powerful tool to investigate surface magnetism down to atomic scale [1]. To achieve a high spin contrast in the SP-STM images, the spin-polarization of the magnetic probe tip should be sufficiently large. Although there have been several proposals to enhance the tip spin-polarization, such as by using half-metallic magnetic materials, these are still not available for routine SP-STM applications. Recently, it was demonstrated that a controlled contact with a magnetic substrate, leading to a change in the magnetic tip apex structure, can alter the degree of tip spin-polarization [2]. An alternative approach for the tip modification would be by picking-up a magnetic atom or a small cluster from the sample surface which may also change the spin-polarization of the magnetic tip. However, this approach has not yet been utilized for the enhancement of the spin-polarization of a magnetic thin film tip.

Here, we report on SP-STM investigations of Mn films grown on Fe(100) single crystal substrates using a magnetic thin film tip. We have observed a significantly enhanced spin contrast due to the tip modification, presumably caused by the attachment of a magnetic cluster at the tip apex [3]. This is supported by the observation of sharp peaks in the normalized dI/dV spectra which is attributed to the tunneling from d -like localized tip electronic states. These results are consistent with a recent theory which predicted a high vacuum spin-polarization of a Fe coated tip with a Mn apex adatom in the antiferromagnetic spin alignment [4]. Our study suggests that a controlled modification of magnetic thin film tips using atom manipulation technique [5] can provide a routine way to achieve high spin sensitivity in atomic scale magnetic imaging.

References

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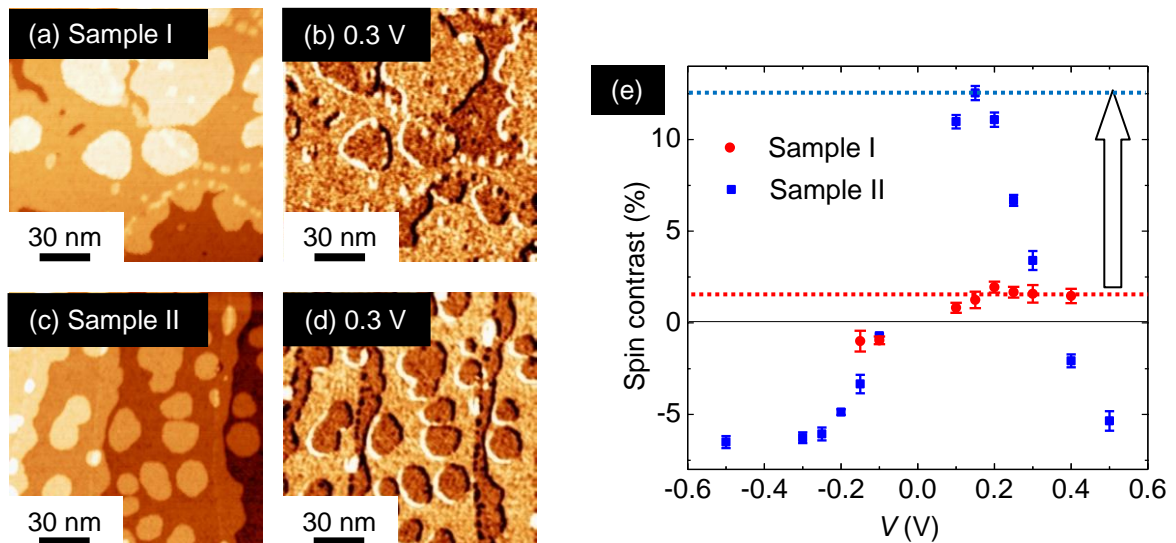


Figure 1: STM topographs (a, c) and dI/dV images (b, d) of two similarly grown 7.2 ML Mn films on Fe(100) substrate. The SP-STM measurements were carried out sequentially on the two samples (I and II) using the same magnetic tip. (e) The spin contrast variation as a function of sample bias voltage.