Fabrication and characterization of nanometer-scale Fe patterns

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Atomic force microscopy (AFM) has attracted much interest in the nanofabrication of materials. This process can produce Si and metal oxide line patterns with a high lateral resolution. Such a patterned oxide layer is potentially useful as a mask for subsequent etching or material growth. In this study, we have investigated the chemical modification of a N-type Si(100) with H-passivated surface [1] by an AFM in contact mode (with ambient humidity at ~60%) to generate silicon dioxide (SiO_2) pattern structure as measured by X-ray photoelectron spectra (XPS). These samples were then etched in 25% TMAH solution for 10 sec. This mask layer (SiO_2) withstood the wet etching process for selective removal of the unmodified area of silicon sample that could increase the height of the fabricated silicon dioxide lines. The TMAH solution selectively etched the unmodified Si area, while the modified area protected by the oxide was not etched. After the oxide pattern was written [2], a 20 nm thick Fe film was deposited on the surface by using an electron beam evaporator, as shown in Fig. 1. The sample was then annealed at a range of 100~450℃. As-deposited Fe film on Si, the FeSi and Fe_2Si compounds have grown. For 450℃ case, this anneal fully diffuses the Fe into the Si where it reacts to create a non-magnetic Fe-Si metallic compound. In the regions protected by the AFM-generated SiO_2, the Fe films that growth onto the SiO_2 maintained the magnetic properties yet and displayed a polycrystal structure. The magnetization reversal and magnetic domain structure of the unreacted Fe film were investigated by magneto-optical Kerr effect (MOKE) and magnetic force microscopy (MFM) measurements, respectively. The AFM and MFM showed that the Fe film strongly influenced with the shape anisotropy which based on the SiO_2 patterns fabricated by AFM oxidation.

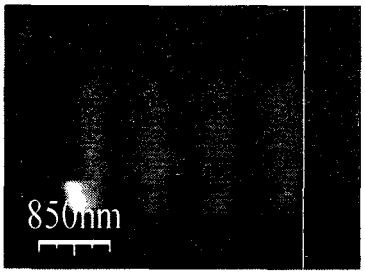

Fig.1. Fe film deposited on SiO_2 patterns that generated by AFM.

References

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