

1P013 Fabrication of high-density ferromagnetic nanowire arrays by laser plasma deposition into nanohole arrays (慶大理工¹・JST-CREST²)

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The shape anisotropy is the most outstanding difference between ferromagnetic (FM) nanowires (NWs) and FM nanoparticles. The anisotropy makes the electron spin of the FM NWs orientated and also thermal fluctuations suppressed in the system of a few nanometer diameters. Since the FM NWs can have a high remanence ratio, the magnetic properties are utilized for “perpendicular magnetic recording”. In this work, we tried to fabricate a variety of FM NWs by a direct conversion of the corresponding bulk magnets, using the pulsed laser plasma (PLP) of the Fe by the deposition onto alumina template with nanohole arrays. As the result, not only the Fe NWs but also the self-assembled grown film was produced.

Alumina templates with self-assembled nanoholes were prepared by two-step anodizing processes for a high purity aluminum substrate (99.999 %) in 0.3 M oxalic acid. The constant voltage of DC 40 V, and a platinum counter electrode were used. The

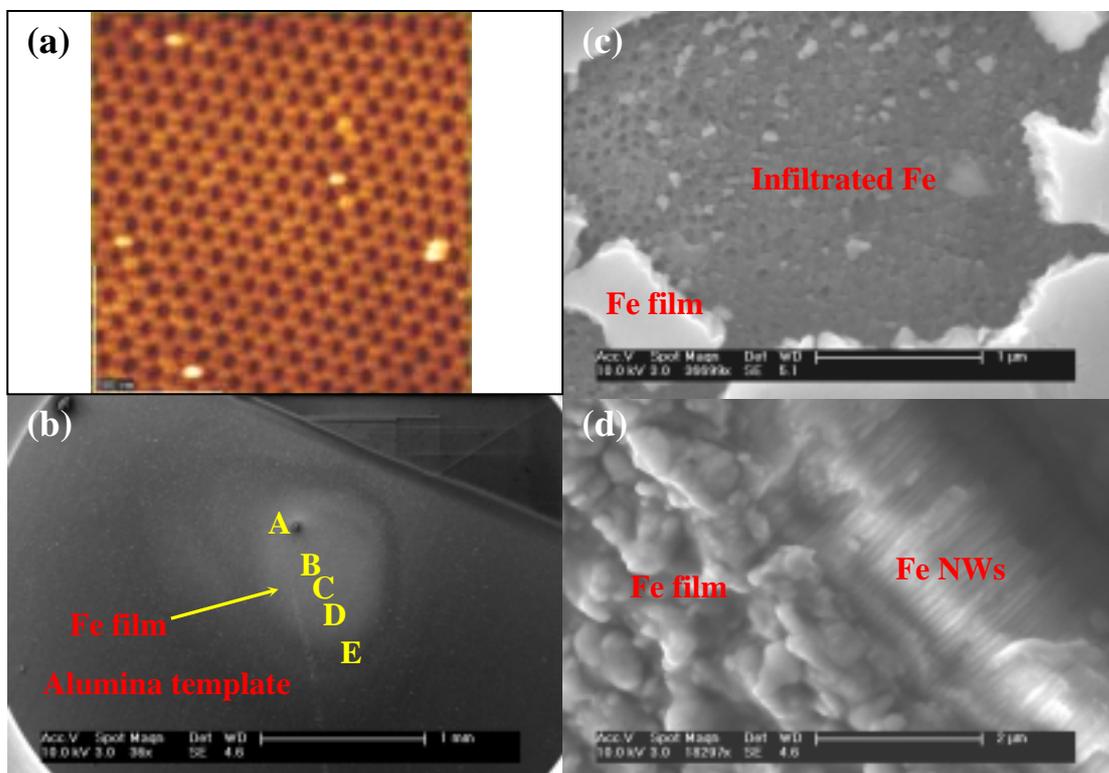


Fig. 1. An AFM image of alumina template ((a)), SEM image after the Fe PLP deposition ((b)), the top view image of the infiltrated Fe into nanohole arrays below the Fe film ((c)), and the section view image of the Fe NW arrays embedded in alumina template ((d)).

wavelength of the photons used was 532 nm from a Nd³⁺:YAG laser; the typical laser energy was ~15 mJ/pulse at a repetition rate of 10 Hz. The surface morphologies of the alumina template before and after deposition were characterized with an atomic force microscope (AFM) and a scanning electron microscope (SEM).

Figure 1(a) shows the AFM image for the alumina template. After the PLP deposition, the alumina template was partially covered with the Fe film as shown as the somewhat white color in the Fig. 1(b). As shown in the top view of Fig. 1(c), below the Fe film, the infiltrated Fe into nanoholes were observed around the area of “A” in the Fig. 1(b). The section view of the Fig. 1(d) also shows the Fe NWs. However, other areas of “B-E” in the Fig. 1(b) do not show the Fe NWs. This indicates that the Fe NWs were fabricated near the plasma center. Interestingly, there is a self-assembled grown film at the area of “B-E” as shown in the Figs. 2(a)-(d). The growth of the double layer was also observed. The elemental blocks in the self-assembled film was observed as somewhat long shaped. More details will be discussed in the presentation, including the results of the alumina thin film, and the patterned silicon wafer prepared by electron beam lithography.

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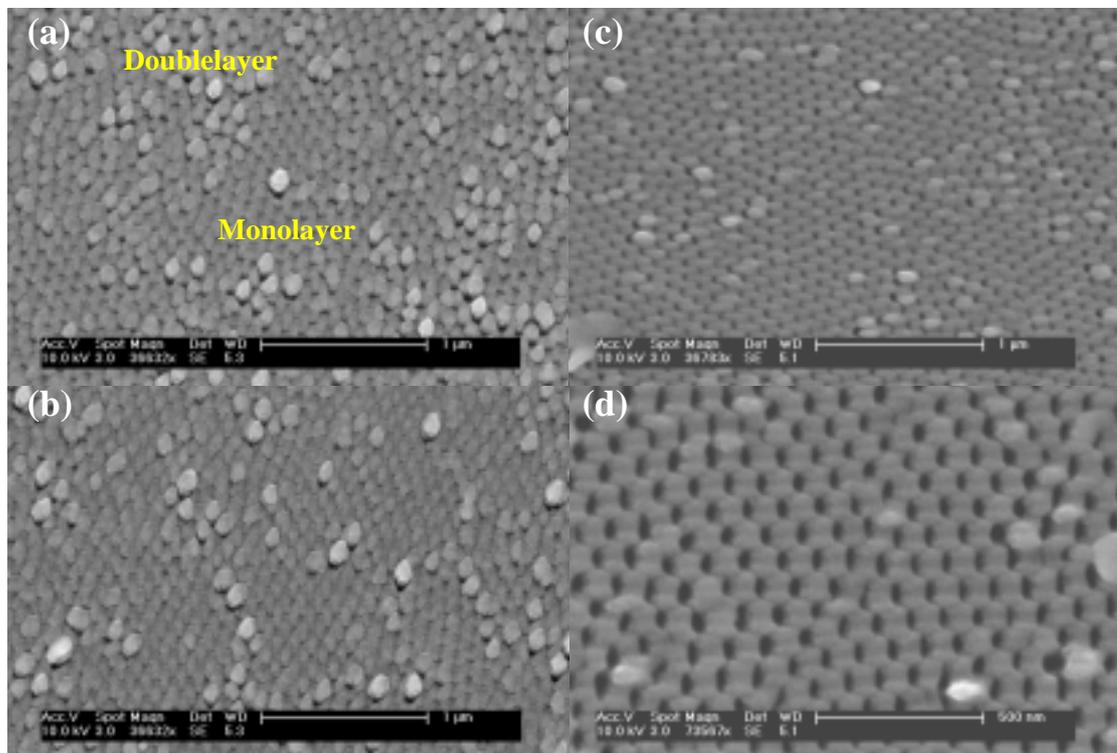


Fig. 2. SEM images of the patterned growth on the alumina template.