Effects of the Flatmilling® on the AFM Observation of a Nd-Fe-B Magnet

SHEET No. 005

Instruments: Environment control AFM AFM5300E
Hybrid Ion Milling IM4000 Plus

Introduction

To observe the nano-structure, the composition and the physical properties of the same crystals and grain boundary area, a prior flattening of the desired sample surface is extremely necessary. However, as polishing flaws and residue of polishing agents on a mechanically polished sample surface may affect the observation it is not the ideal observation surface. The ion beam flatmilling® process will be the optimal preparation method for this purpose. In this data sheet, the and mechanically polished surface and the additionally ion-milled surface of a hot-deformed Nd-Fe-B permanent magnet was observed with the magnetic force microscopy (MFM) and the results of the topography and the magnetism distribution were compared.

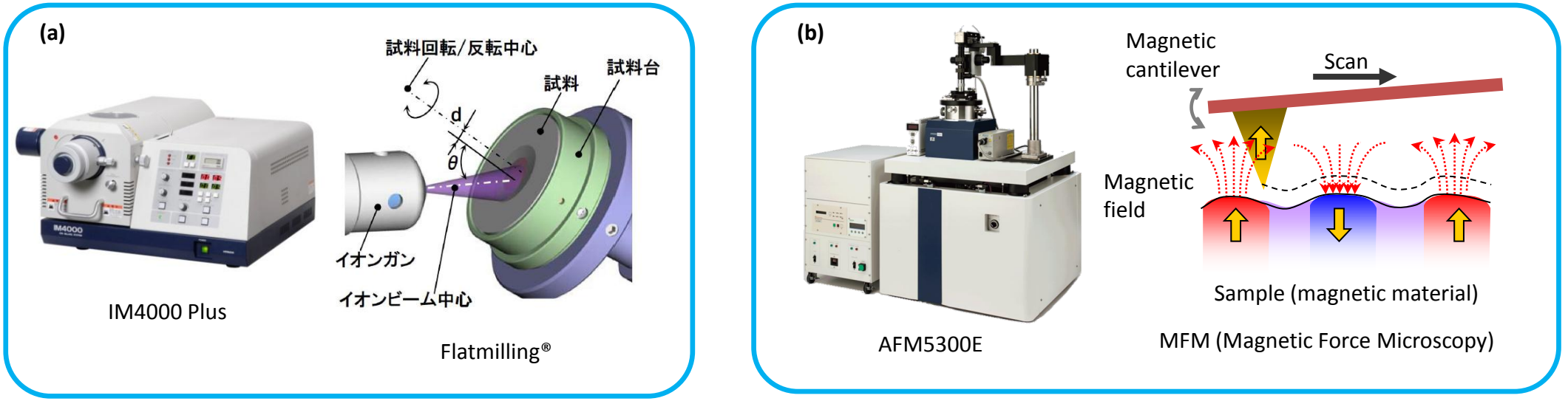

Figure 1: Principle of flatmilling® and MFM observation

Results

In figure 2, the MFM observation results of a hot-deformed Nd-Fe-B magnet before and after the ion-milling process are shown. Before the ion-milling, the mechanical polishing is less satisfying. Referring to the AFM image (topography image), polishing flaws and residuals of polishing agents are visible. The simultaneously measured MFM image (magnetism distribution image) is not clear too. However, after the ion-milling process the flaws on the surface are vanished and the crystals and grain boundaries are clearly visible. Furthermore, the resolution (image quality) of the MFM image has improved significantly.※

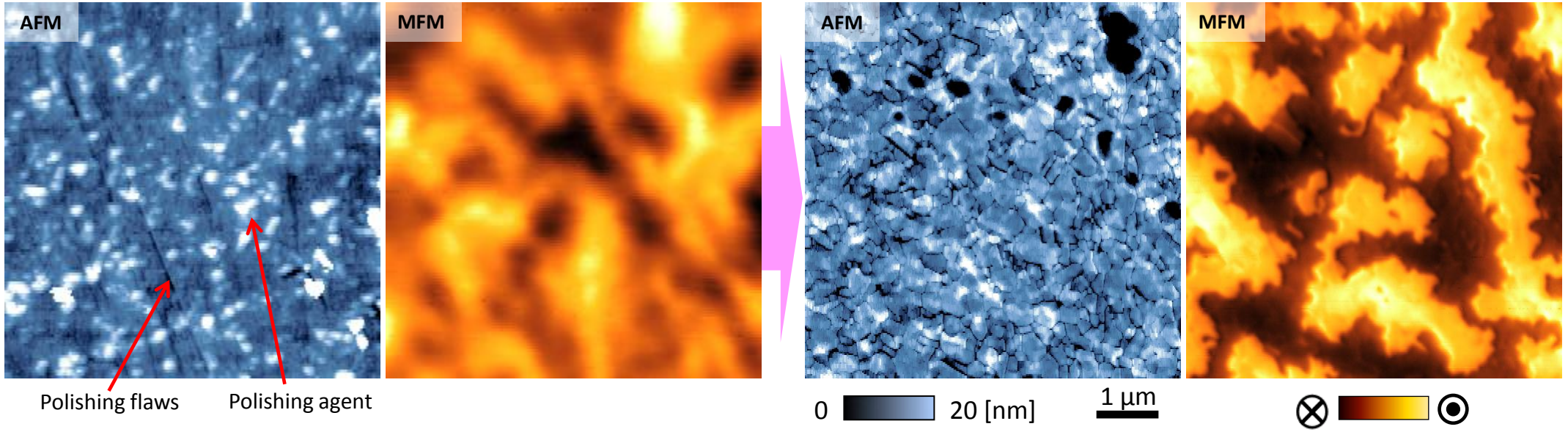

Figure 2: MFM observation results of a hot-deformed Nd-Fe-B magnet before and after the ion-milling processing (Sample courtesy: Daido Steel Co., Ltd.)

※ For the MFM measurement, a high-coercitivity MFM cantilever (coercitivity >10 kOe) was used as it can withstand the strong magnetic field from a permanent magnet. At a completely thermally demagnetized state, it is expected that the amount of N-pole and S-pole areas are equal. The MFM image after the ion-milling process shows that the maze-like shaped light and dark areas are equally distributed. Therefore, it is proven that the magnetic domains were observed accurately with high resolution.

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