

Spacer protective surface coat for cutting-edge ion-beam lithography

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We demonstrate the successful use of Spacer 300Z,¹ a highly conductive water-soluble polymer (polyisothianaphthene-sulfonate), as a protective coating in high resolution focused ion-beam lithography. Our studies show that an Spacer coating can not only be an efficient discharge layer, but it can also serve as a protective surface coat that blocks low-level ion exposure. This is especially important in preserving a sharp edge profile for ion-beam cuts.

We tested 50 nm thick Spacer coats on both conductive and non-conductive samples. The polymer was spin-coated and baked at 90 °C for 1 min on a hotplate prior loading the samples for ion-beam milling. Focused ion-beam lithography was carried out in an FEI Nova 600 NanoLab instrument with milling parameters of 30 kV acceleration voltage and Ga⁺ ion beam currents from 10 pA up to 1 nA. Various patterns, including thin trenches and large-area clearing of material, were prepared. The Spacer coat was then removed in water, and the samples were inspected for pattern definition quality and possible structural damage. We present comparative studies of samples fabricated with and without a protective coat.

As an example for a successful application, Figure 1 shows an array of 1 μm diameter disks milled out from a 25 nm thick CoFe/IrMn bilayer thin film supported on a 50 nm thick silicon nitride membrane. In this case, superior edge definition and an intact magnetic interface were both important outcomes of the lithography process because of their effect on the magnetic behavior of the disks.

Conducting polymers as effective discharge layers have many potential applications in microelectronics.² In this study, we introduce a rather unusual application in fabrication technology, which can serve the ion-beam lithography community well.

¹ Produced by Showa Denko K. K., Japan.

² M. Angelopoulos, "Conducting polymers in microelectronics," *IBM J. Res. & Dev.* **45**, 57-75 (2001).

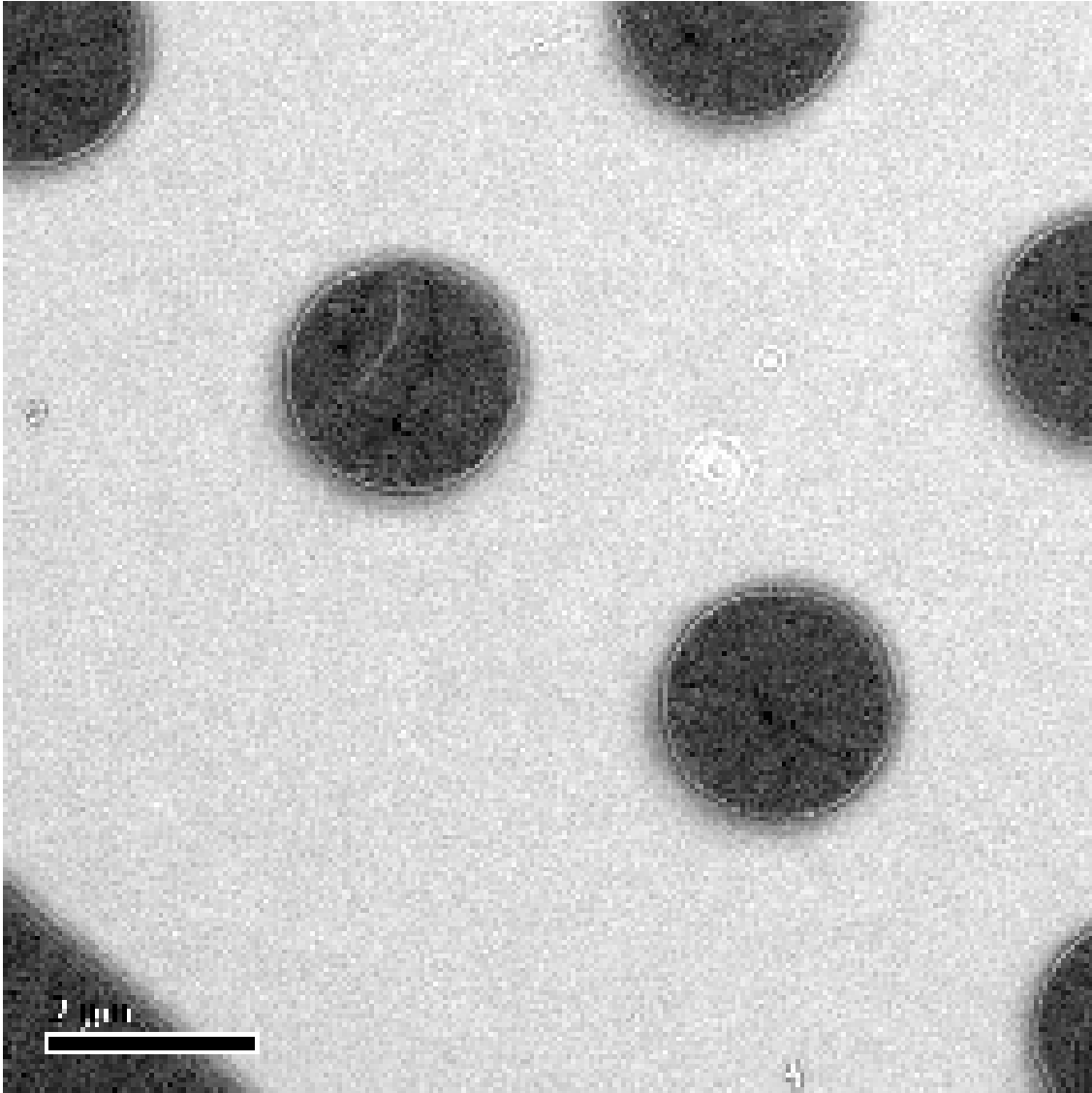


Figure 1. Transmission electron microscope image of CoFe/IrMn bilayer magnetic disks on a thin membrane, patterned by focused ion-beam lithography from a continuous thin film. Protective Spacer coating was used during the milling process in order to improve shape definition and to prevent ion damage in the material. The scale bar represents 1 μm .