Electrochemical Processing for Cu and Ni Nanowire Arrays

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The nanoscaled magnetic wire array has been of great interest as patterned magnetic recording media, sensor devices, and energy conversion and storage devices. Current nanofabrication techniques for nanostructured devices include the electron-beam, the interferometric lithography and the microprobe-assisted manipulation [1]. These methods in vacuum system are relatively time consuming and expensive. Another candidate is found in the electrodeposition of metal into templates. Electrodeposition has the attractive features of cost-effectiveness, simplicity in operation, and the ability of deposition onto substrates with complex geometries. In this study, Cu and Ni nanowire arrays have been electrodeposited into polycarbonate(PC) track-etched membranes with nano-sized pores at various constant potentials.

Experimental

One side of a PC membrane surface with 200 nm-sized pores was sputtered with Pt-Pd alloy. The thickness of sputtered layer was roughly several tens of nm. It works as a cathode substrate, when a pore is filled with electrolyte. 0.6 M $CuSO_4$ aqueous solution at pH = 2 and organic-free Watt's bath containing 280 g/l $NiSO_4 \cdot 7H_2O$, 45 g/l $NiCl_2 \cdot 6H_2O$ and 38 g/l H_3BO_3 were used for Cu and Ni electrodeposition, respectively. The pH value of electrolyte was adjusted by H_2SO_4. Electrodeposition was performed at room temperature, and applied potential was controlled with respect to Cu or Ni wire as a conventional reference electrode. It was faced to the cathode surface with 3 mm distance away.

Results and Discussion

Figure 1 shows SEM image of the Pt-Pd substrate. It is seen that many pores are still open. That means the sputtered Pt-Pd film is not enough to cover all over the surface of the backside of the membrane.

Figure 2 shows the initial stage of *I-t* curves during electrodeposition of Cu and Ni nanowire with 200 nm diam. The transient current variation for Ni electrodeposition is much enhanced than the case for Cu.

Figure 3 (a), (b) and (c) show SEM images of backside of the membrane at 5, 10 and 26 sec after stating Cu electrodeposition, respectively. The amount of deposited Cu on the backside increases as duration period increases. Many pores are still seen in Figure 3 (a), but almost all of them disappear in (c).

Figure 3 (d) shows the backside of the membrane after Ni nanowires was electrodeposited into a membrane. The duration period was 400 sec. White-colored area around the pores corresponds to electrodeposited Ni, while the black part does to Pt-Pd film. The difference between Cu and Ni electrodeposition into nano-sized pore should be discussed.

Reference

[1] M. Zheng, et al., *J. Phys.: Condens. Matter* **12**, L497 (2000)

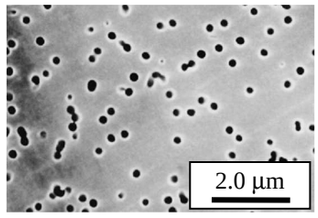

Figure 1. SEM image of the backside of the membrane sputtered with Pt-Pd. Pore size is 200 nm diam.

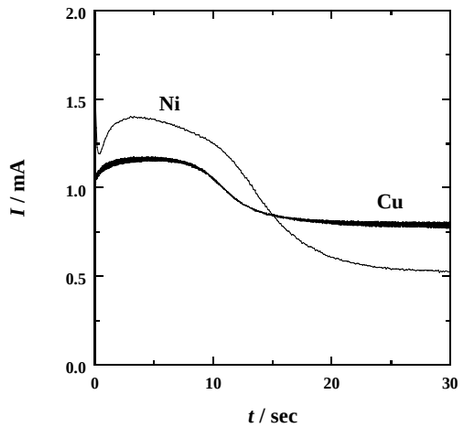

Figure 2. *I-t* curves for Cu and Ni electrodeposition into membrane with 200 nm-sized pore.

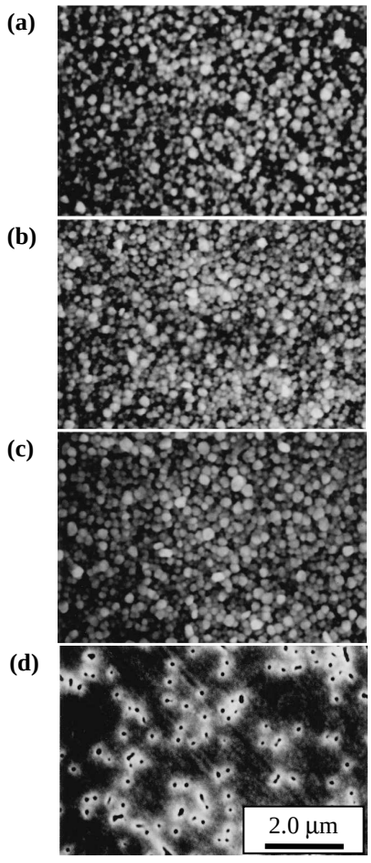

Figure 3. SEM images of the backside of the membrane at (a) 5, (b) 10, and (c) 26 seconds after starting Cu electrodeposition into pores, and (d) Ni nanowires fabricated completely by the emergence of Ni to the membrane surface.