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Fabrication of 3 μm Bubble 80 kbit Chips

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Based on the successful 6 μm bubble technology[1] and in order to improve its cost-performance, we have been developing a 3 μm bubble 80 kbit chip. Here, we report the development of its fabrication process.

The propagation pattern for 3 μm bubbles was designed by 1/2 scaling from the pattern for 6 μm bubbles[2]. The period, bar width and pattern gap is 14 μm, 2 μm and 1 μm, respectively. The fabrication process is almost the same as that of the 6 μm bubble chip[1]. The thicknesses of overlay films were optimized as follows; 2000 Å 1st SiO_2 spacing layer, 2500 Å AlCu conductor layer, 5000 Å 2nd SiO_2 spacing layer and 3500 Å permalloy layer.

The resolution of 1 μm over 6 mm square can be achieved only by exploiting photolithography to the limit and for this purpose we have employed the direct projection printing. Fig. 2 shows the schematic of its system. The optical system is corrected for 4358 Å, its magnification is 1/10 and its resolution is 1 μm over 7.2 mm diameter with 4 μm focal depth.

With the monochromatic illumination, there is a well-known problem of standing wave effects[3]. Fig. 3a shows a photograph of AlCu conductor pattern. Even when the pattern was exposed in just focus on 5500 Å AZ1350 photoresist and etched thoroughly by ion milling, there still remains thin AlCu at the small pattern gap. Fig. 4a shows a SEM photograph of etched permalloy patterns. These patterns are over-etched because excess ion-milling was needed to etch-out 1 μm pattern gap and this is remarkable around the step of the conductor pattern. We have adopted anti-reflection coating to prevent these standing wave effects. Fig. 3b shows an improved conductor pattern with a 200 Å Ti coating, where the reflectance is reduced from 85 % of AlCu to 54 %. Although the reflectance of the permalloy film is 52 % and nearly equal to that of the Ti coating, it should be further reduced to obtain satisfying patterns. Fig. 4b shows the etched permalloy pattern improved by using rough surface permalloy film, where the reflectance is reduced to 33 %. This rough surface is the replica of the 1st SiO_2 surface which is roughened by the ion-milling of AlCu layer in normal incidence. Fig. 4c shows the result of utilizing a 200 Å Cr_2O_3 coating on the smooth permalloy film, where the reflectance is reduced to 8 %. In this case completely uniform 2 μm width and 1 μm gap can be obtained notwithstanding the variation in photoresist thickness and uneven substrates. Fig. 5 shows an example of operating margin curve of the

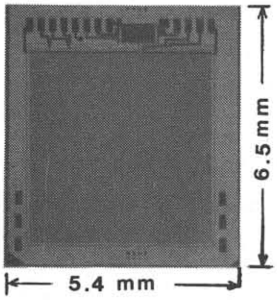

Fig.1. 80-kbit bubble memory chip

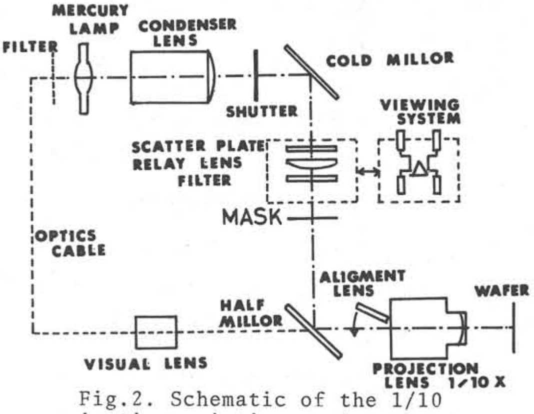

Fig.2. Schematic of the 1/10 projection printing system.

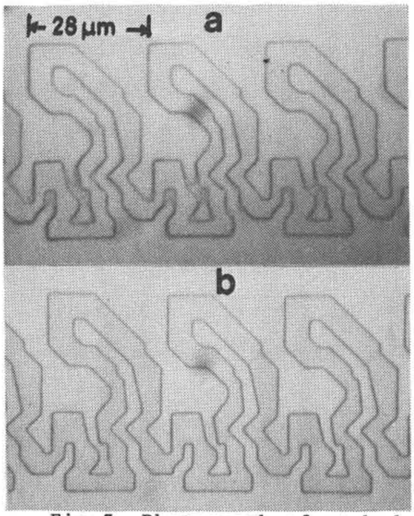

Fig.3. Photograph of etched Al-Cu conductor pattern without anti-reflection coating (a) and with anti-reflection coating of 200Å Ti film(b).

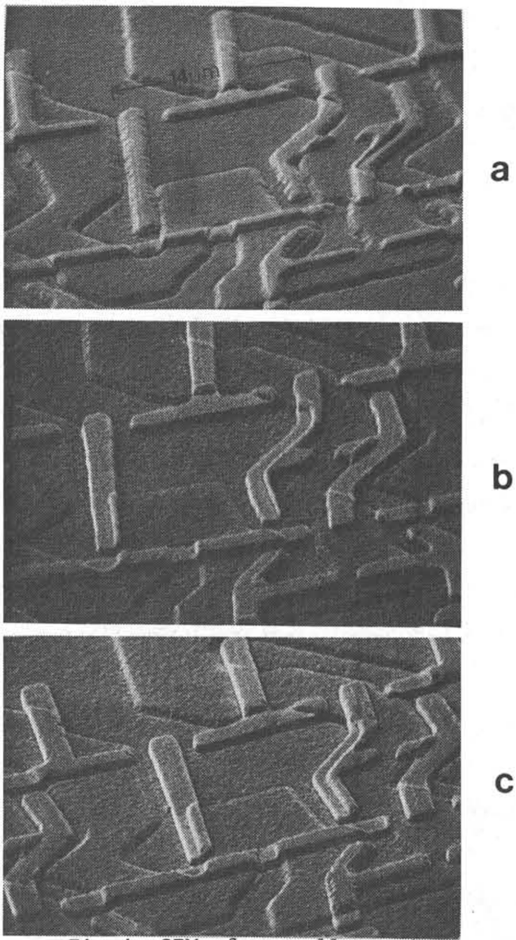

Fig.4. SEM of permalloy patterns; smooth surface permalloy film(a), rough surface one(b) and smooth surface permalloy film with anti-reflection coating of 200Å Cr_2O_3(c).

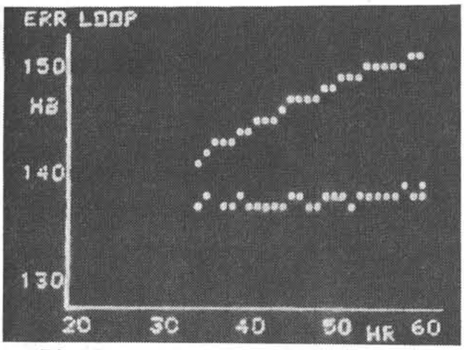

Fig.5. Typical operating margin of the 80-kbit chip at 300kHz (major loop).

fabricated 80 kbit chip driven by 300 kHz triangular wave.

(1) S. Sakai et al: Proc. 7th Conf. Solid State Devices, Tokyo, 1975.
(2) S. Igarashi et al: Conf. on Magnetism and Magnetic Materials 1975.
(3) S. Middelhoek: IBM J. Res. Develop. 14 (1970) 117.