Lawrence Livermore Laboratory

Fabrication of Mandrels for Making
Ten Micron Thick Gold Discs for the
Target Fabrication Group of Y-Division

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January 6, 1977

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Prepared for U.S. Energy Research & Development Administration under contract No. W-7405-Eng-48.

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Fabrication of Mandrels for Making
Ten Micron Thick Gold Discs for the
Target Fabrication Group of Y-Division*

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Abstract

This paper describes the design and fabrication of a unique silicon substrate on which gold is sputtered. It produces a finished part and eliminates the need for any etching or other processing. Several different sizes of gold dots and donuts from 50 to 750 microns diameter by 10 microns thick have been made and the process appears to be quite successful.

Introduction

There is a need at this Laboratory for gold films of various thickness, shapes, and sizes. In this particular case they are 50 to 1000 micron diameter, ten micron thick gold discs. Several methods for fabricating these discs were tried and all proved to be very difficult and time consuming, producing only one part at a time. One method of producing a gold disc of this type would be to use the standard photolithographic technique used in integrated circuit semiconductor processing. This approach uses a photolithographic mask to reproduce the disc on a gold substrate. The advantage of using this technique is that you get many parts from a single wafer and all are identical.

The problem in using this method is that ten microns is a very thick film to chemically etch, due to the severe problems of photoresist adhesion and undercutting. Also it can be very difficult to remove the gold discs from the substrate after they are etched.

*This work was performed under the auspices of the U.S. Energy Research and Development Administration under contract #W-7405-Eng-48.

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Substrate Design

What is presented here is a method that will eliminate the chemical etching and also allow the easy removal of the gold discs from the substrate. Since gold does not adhere very well to SiO_2 , a silicon substrate was designed to allow the gold to be sputtered on the substrate and then simply peeled off, giving you a finished target.

Fabrication Process

The final process turned out to be rather simple. We used standard silicon wafers of semiconductor quality. In this case they were "P" type (1-1-1) 8-12 ohm cm, 2" in diameter, and were processed using standard integrated circuit technology in the following manner.

Step Number

1. Grow a one micron thick thermal oxide. Fig. 1A.
2. Apply negative resist and spin at 3000 RPM. Fig. 1B.
3. Soft bake at 90°C for 10 min.
4. Photolith pattern from mask using a 5 second exposure time @ 10 MW/cm². Fig. 1C.
5. Develop using a 25 sec. develop time, 25 sec. rinse time and 30 sec. N₂ dry.
6. Hard bake @ 150° C for 15 min.
7. Chemically etch the one micron oxide in a 6:1 (NH₄ + F:HF) solution. Fig. 1D.
8. Plasma etch in Freon + O₂ @ 0.5 torr pressure and 150 watts power for 30 min. This etches nine microns into the silicon. Fig. 1E.
9. Plasma strip resist in O₂ @ 0.5 torr pressure and 150 watt power for 15 min. Fig. 1F.
10. Grow 3000 Å thermal oxide. This is necessary to prevent the gold from sticking to areas that were plasma etched. Fig. 1G.

The finished profile (Fig. 1G) is a pattern of SiO_2 10 microns above the silicon substrate and well undercut to allow the gold to be sputtered on and separate in the necessary areas.

For the sake of simplicity the figures represent a silicon SiO_2 dot of ~ 50 microns diameter. To date several gold dot and donut shaped discs from 50 to 750 microns in diameter by ten micron thick have been made and the process appears to be quite successful. Fig. 2 shows a photomicrograph of a 10 micron thick gold donut that is 550 microns O.D. X 150 microns I.D.

Figure 1. Profile of Steps in the Fabrication of Silicon Wafer Prior to Gold Deposition.

Figure 2. SEM Photomicrograph of an Au Disc 8 Microns Thick and 550 Microns O.D. X 150 Microns I.D.

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