課題番号 :F-19-AT-0125
利用形態 :機器利用
利用課題名（日本語） :
Program Title(English) :Design and Fabrication of Photomask for Microneedle Pad Production
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キーワード／Keyword :リソグラフィ・露光・描画装置、膜加工・エッチング、形状・形態観察、分析

1．概要（Summary）

This project focusing on design and fabrication of silicon photomask to produce a microneedle pad. The silicon wafer was etched to create through-hole arrays by wet etching on the back side and deep RIE on the front side. Pattern feature providing high yield of microneedle production was investigated by varying hole diameter and distance between the holes.

2．実験（Experimental）

【利用した主な装置】

スピンコーター、マスクレス露光装置、酸アルカリドラフトチャンバー、反応性イオンエッチング装置 (RIE)、多目的エッチング装置(ICP-RIE)、短波長レーザー顕微鏡[OLS-4100]、プラズマアッシャー

【実験方法】

The silicon photomask fabrication performed to the 2-inch silicon wafer has silicon dioxide at both sides. The fabrication step as follows.

1. Cleanroom sticker with 4x4 mm^2 square pattern was attached on the backside of the silicon wafer for used as a mask in oxide removal.
2. Thermal oxide on the back-side of the wafer was removed by RIE technique using O_2:CF_4 17:54 SCCM, power 80 W, and pressure 5 Pa for 30 min.
3. The wafer was etched in TMAH solution at 90℃ on hot bath stirrer for 6 hours, expecting the wafer was etched as 250-270 µm remaining the thickness is 20-40 µm.
4. The front side of the silicon wafer was incubated in HMDS vapor for 1 min before coated with PMER P-HA1300PM by spin-coating technique. After that, the photoresist film was pre-baked at 110℃ for 10 min.
5. The maskless exposure machine was used to create a circle array pattern on the photoresist film. After that, the film was developed in PMER P-7G, alternating with water for 2 times and post-baked at 110℃ for 6 min.
6. Thermal oxide on the front side was removed by RIE technique using O_2:CF_4 17:54 SCCM, power 80 W, and pressure 5 Pa for 60 min.
7. After the oxide removal, the silicon was etched using Bosch process with 60 cycles for 4 times.
8. The sample was cleaned by plasma asher at 300 W for 30 min.

3．結果と考察（Results and Discussion）

For etching results on the backside of the silicon wafer, the oxide layer as a large pattern can be completely removed by the RIE technique using 30 min. The silicon etched in a depth of around 260 µm using TMAH at 90℃ for 6 hours, consistent with the etching rate of 43.3 µm/h. This process helps to reduce the lithography process.

For the front side etching, the circle pattern was designed with diameter is 5, 10, 25, and 50 µm. Optical microscope image after oxide removal by the RIE machine is shown in Figure 1A. Display with the silicon etched by using 240 cycles of the

Bosch process indicated that the width of the resulting holes is 10.8, 23.0, 45.0, and 73.0 μm. While the depth of the resulting holes is 36.2, 44.0, 55.0, and 60.0 μm, respectively. Following the resalts of width and the depth we can discuss the aspect ratio of the etching hole depends on the size of the pattern. The smaller pattern diameter provided to the higher aspect ratio.

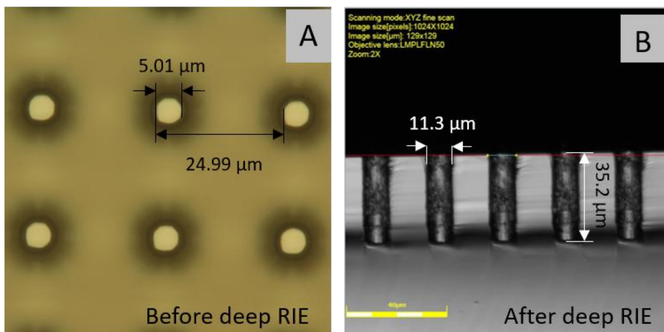

Figure 1: A) Optical microscope of the pattern after oxide removing step, B) picture from 3D optical microscope of the hole after 240 cycles of Bosch process with the starting pattern diameter of 5 μm.

4. その他・特記事項（Others）

なし

5. 論文・学会発表（Publication/Presentation）

なし

6. 関連特許（Patent）

なし。