課題番号　:F-21-UT-0082
利用形態　:機器利用
利用課題名（日本語）　:
Program Title (English)　:Fabrication of Diamond Like Carbon (DLC) based superhydrophobic surface
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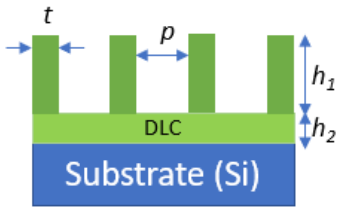
キーワード／Keyword　:リソグラフィ・露光・描画装置、膜加工・エッチング、Diamond Like Carbon, EB lithography, reactive ion etching, Teflon coating, superhydrophobic surface.

1. 概要（Summary）

This year, we also fabricated DLC based superhydrophobic surface (SHS) but with different pillar spacings. Last year, we basically developed and finalized the recipe for p = 2 μm on trial-and-error basis. This year, we are making the final products to be used in the experiment. We fabricated surfaces with three different spacings, i.e., p = 2, 6 and 16 μm. Other dimensions are same as shown in Fig. 1.



Thickness, t = 1.0 μm
Spacing, p = 2.0 μm
Height, h_1 = 3.0 μm
Height, h_2 = 1.0 μm
Tolerance = ±0.3 μm

Fig.1: Key dimensions of intended SHS

2. 実験（Experimental）

【利用した主な装置】

クリーンドラフト潤沢超純水付、8 インチ汎用スパッタ装置、高速大面積電子線描画装置、汎用高品位 ICP エッチング装置、汎用 ICP エッチング装置

【実験方法】

A short description of the process steps is given below:

i. Deposit DLC layer on Si substrate by CVD (performed outside of Takeda).
ii. Cut the wafer into 2 * 2 cm chip manually.
iii. Organic cleaning using Acetone, ethanol, and water.
iv. Sputtering of Al hard mask (100 nm thick) using SIH-450 ULVAC.
v. O_2 plasma ashing to improve adhesion of surface.
vi. Spin coat of OAP (0 rpm / 1 sec. – 500 rpm / 5 sec. – 3,000 rpm / 30 sec.) and ZEP520A (0 rpm / 1 sec. – 500 rpm / 5 sec. – 4,000 rpm / 60 sec.) as EB resist.
vii. EB lithography (ADVANTEST F5112+VD01), dose: 104 μC/cm², time: 24 min
viii. Development: ZND-50 60sec., MIBK 10sec., IPA 10sec., dry with N_2 gun.
ix. Etching of Al hard mask (Cl_2 plasma) with ICP-RIE ULVAC NE-550
x. Etching of DLC layer (O_2 plasma) with ICP-RIE-ULVAC CE-300I.
xi. Removal of Al hard mask and resist by chemical etching.
xii. Teflon coat of pillars with DRIE SPPT MUC-21 ASE Pegasus.

3. 結果と考察（Results and Discussion）

Top view of the two surfaces with pillar spacing 2 μm and 6 μm are shown in Fig. 2 and Fig. 3 respectively. Surface with spacing 16 μm will be fabricated in the near future. However, we can see that, pillars were not created on SHS with 6 μm

spacing. This is because we used same etching recipe for both surfaces. We need to modify etching recipe for 6 μm surface and 16 μm surface.

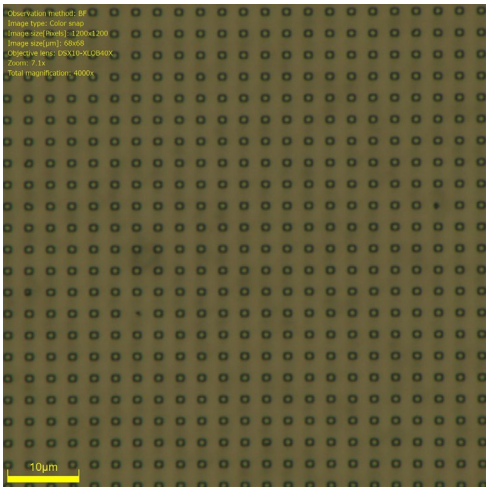


Fig. 2: Top view of SHS (spacing 2 μm)

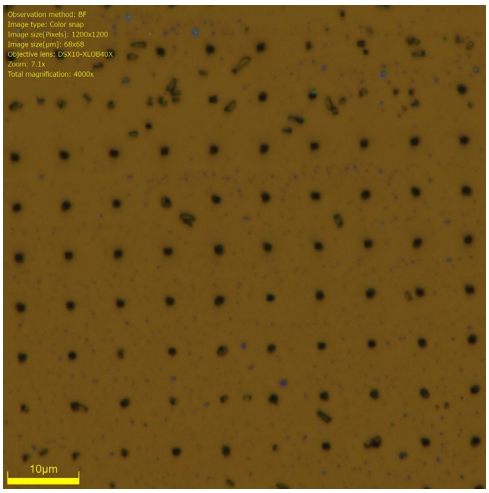


Fig. 3: Top view of SHS (spacing 6 μm)

Static contact angle measurement by tangent method for both surfaces are shown in Fig. 4 and Fig. 5. We can see that; both of the surfaces are not superhydrophobic yet. On 2 μm spacing surface, although pillars were created successfully, we made some scratches during handling of this surface, and it damaged the superhydrophobicity. Top view of damaged area is shown in Fig. 6. On 6 μm surface, contact angle is low because pillars were not created properly. We have to take care of these issues while fabricating new surfaces in the near future.

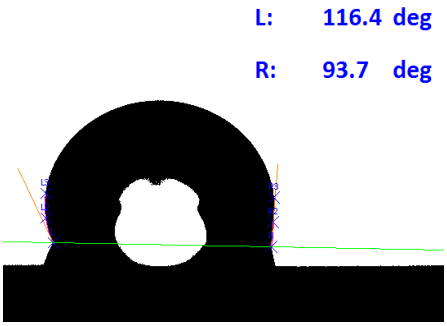


Fig. 4: Static contact angle (spacing 2 μm)

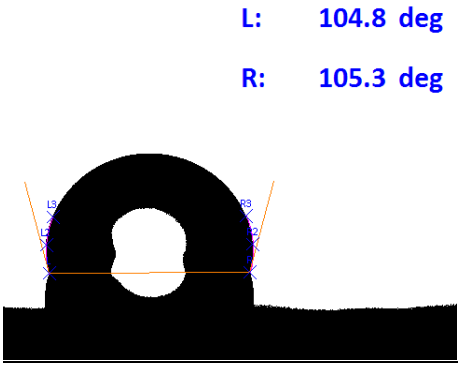


Fig. 5: Static contact angle (spacing 6 μm)

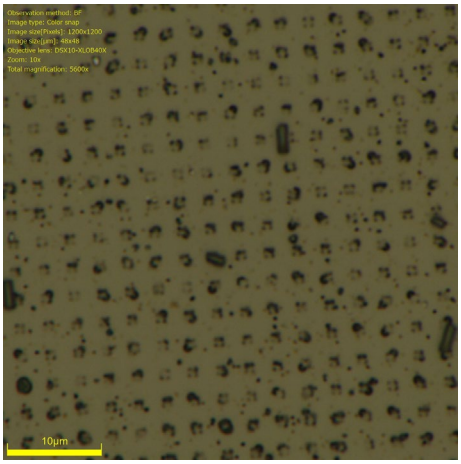


Fig. 6: Damaged area by scratch on 2 μm spacing surface

4. その他・特記事項(Others)

None

5. 論文・学会発表(Publication/Presentation)

We planned to complete this project by the end of March 2022 and to publish afterwards.

6. 関連特許(Patent)

None