課題番号　　　　　　　　:F-20-UT-0134
利用形態　　　　　　　　:機器利用
利用課題名(日本語)　　　:
Program Title (English)　:Fabrication of mechanically strong structured superhydrophobic surface using Diamond Like Carbon (DLC)

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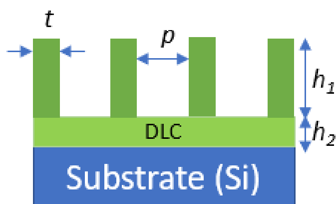
キーワード／Keyword　　:リソグラフィ・露光・描画装置、膜加工・エッチング、Diamond Like Carbon, chemical vapor deposition, EB lithography, reactive ion etching, micropillars, Teflon coating, contact angle, superhydrophobic surface.

1. 概要(Summary)

This project aims to fabricate a mechanically strong structured (micropillars) superhydrophobic surface (SHS) using Diamond Like Carbon (DLC). The key dimensions of the SHS that we intend to fabricate is shown below. A brief description of fabrication steps is given in section-2 (experimental).



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

We anticipate that, upon successful development of such a patterned SHS with DLC will greatly help to overcome the durability issue of SHS available in the literature. Also, the new fabrication methodology will open the room for commercial production of such a mechanically strong SHS for various engineering applications.

2. 実験(Experimental)

【利用した主な装置】

ステルスダイサー、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 using Stealth dicer DFL 7340.
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 (0rpm/1sec. - 500rpm/5sec. - 3000rpm/30sec.) and ZEP520A (0rpm/1sec. - 500rpm/5sec. - 4000rpm/60sec.) as EB resist.
vii. EB lithography (ADVANTEST F5112 + VD01), dose: 104 µC/cm2, time: 24 min
viii. Development: ZND-50 60sec., MIBK 10sec., IPA 10 sec., 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. Observation of pillars by SEM.

xiii. Initial contact angle check.

xiv. Teflon coat of pillars with DRIE SPPT MUC-21 ASE Pegasus.

xv. Final contact angle check.

However, until 02/03/2021 we have accomplished steps i to x. The remaining steps (xi to xv) will be carried out in the near future.

3. 結果と考察（Results and Discussion）

A 90 degree SEM of DLC pillars with dimensions (as fabricated) after completing step x (section-2) is shown below. The SEM image was taken by Hitachi Regulus 8230 in CR.

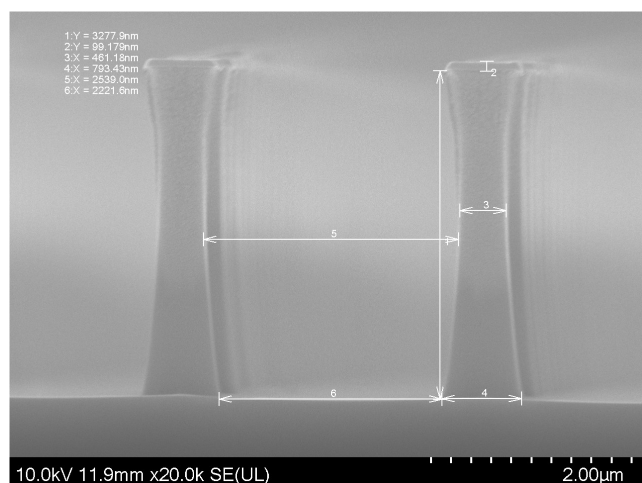


Fig. 2 90 degree SEM of DLC pillars (after step x)

4. その他・特記事項（Others）

None

5. 論文・学会発表（Publication/Presentation）

None

6. 関連特許（Patent）

None