

## Electronic Supplementary Information

# Gas bubble evolution on microstructured silicon substrates

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## Roughness study and its effect on the bubble detachment radius

The roughness in the radial direction at the top of the pits is measured by imaging the apex from the top using Scanning Electron Spectroscopy (SEM). A circle-line is fitted over the pit apex and deviations from the ideal circumference are measured. We then calculate the roughness in radial direction as:

$$R_a = \frac{1}{n} \sum_{i=1}^n |y_i|, \quad (1)$$

where  $y_i$  is the deviation per measurement point. For these calculations, we take points with equal spacing over each circle. We calculate  $R_a$  for various DRIE conditions and fluorocarbon deposition times, but a correlation to the detachment radius could not be found.

To illustrate the complexity of taking the surface roughness into account, we image various substrates. Figure 1A shows partially the inside of a pit with a 7.5  $\mu\text{m}$  radius. Here the black silicon is visible at the bottom half of the image, the top half shows part of the inner wall of the 20  $\mu\text{m}$  deep pit where fluorocarbons have been deposited for 37 seconds after the pit formation. The wall shows non-homogeneity in the surface created during the pit fabrication, which could play an important factor if the bubble is pinned within the pit.

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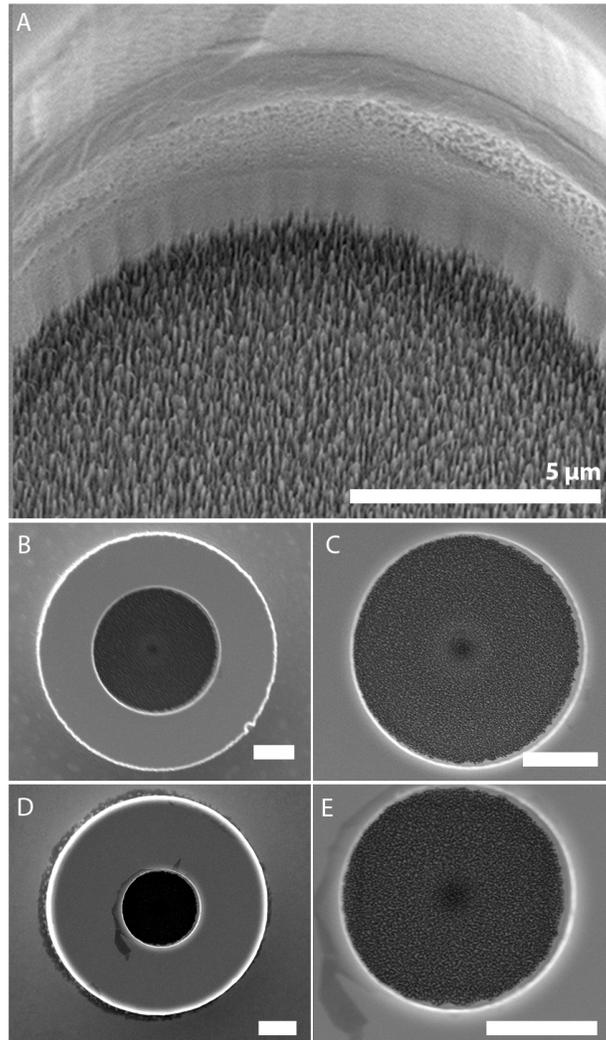
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A top view of a pillar with a  $15\ \mu\text{m}$  radius is shown in Figure 1B, which contains a defect on the outer edge at the bottom right side, providing an irregularity that could influence the bubble detachment size if the contact line moves to the pillar edge. Figure 1C shows a close-up of the pit in the pillar of subfigure B, in which the pit apex is shown in bright white. The pit has a radius of  $7.5\ \mu\text{m}$ ,  $R_a = 0.004\ \mu\text{m}$  averaged by three measurements, and due to the substrate not being levelled under the electron source, a small part of the wall is shown at the right side of the image between the dark black silicon and the bright pit apex. Figure 1D shows a top view of a  $30\ \mu\text{m}$  tall micropillar, with a radius of  $15\ \mu\text{m}$  and pit radius of  $5\ \mu\text{m}$ . Before imaging, this substrate was used in an electrolysis experiment, during which an unknown substance precipitated on the pillar surface near the pit, creating additional pinning locations for bubbles. Subfigure E shows a close-up of this pit with  $R_a = 0.008\ \mu\text{m}$  averaged by three measurements. Similar to subfigure C, a part of the pit wall is shown on the right side between the dark black silicon and bright apex. Although in our experiments roughness does not seem to play any significant role during bubble growth and detachment, its influence warrants further investigation which does not only take into account the pit apex but the roughness of the pit inner wall, the pillar outer wall and the top pillar surface, as well as other defects.



**Figure 1** A) The inside of a micropit of  $20\ \mu\text{m}$  depth and  $7.5\ \mu\text{m}$  radius is partially shown. The substrate is under a  $20^\circ$  angle with respect to the electron beam source. At the bottom of the image, black silicon is visible. At the top, the wall on the inside of the pit shows roughness, a result of the DRIE process. In all subfigures, the white scalebars indicate a  $5\ \mu\text{m}$  length. B) A top view of a pillar with a  $15\ \mu\text{m}$  radius and  $7.5\ \mu\text{m}$  radius pit is shown. A defect from the fabrication of the substrate on the outer edge at the bottom right side of the pillar is present. C) Close-up of the pit shown in B. Here the radial roughness is  $R_a = 0.004\ \mu\text{m}$ . D) A micropillar of  $30\ \mu\text{m}$  height,  $15\ \mu\text{m}$  radius and a pit radius of  $5\ \mu\text{m}$  is shown. A deposit on the surface of the pillar can be noticed near the pit aperture. E) Close-up of the pit from subfigure D. Here,  $R_a = 0.008\ \mu\text{m}$ .