# Fabrication of Micro-size Re-entrant Structure by Two Step Imprint Process

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Studies on the fabrication of omniphobic surfaces have been actively conducted for the purpose of providing special functions such as super-hydrophobic, super-oleophobic, anti-fouling, anti-icing and self-cleaning on the surface. Among them, in order to fabricate an omniphobic surface through imprint lithography process, studied on the fabrication of a re-entrant structure where the upper part of the micro-sized pattern is wider than the lower part. In this paper, the re-entrant structure was fabricated by oxygen inhibition of UV curable resin.

UV curable resins are classified into radical series and cation series as shown in Table 1 and Figure 1 shows radical series react with oxygen to form inert material. Since the generated inert material, the status of curing could be inhibited. Based on these properties, PDMS with higher oxygen permeability than resin was used as a mold material.

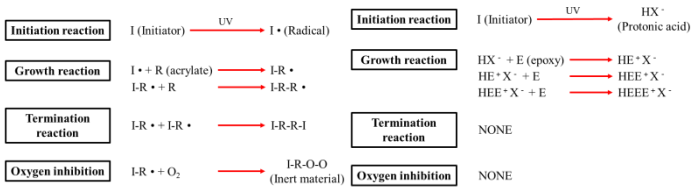


**Figure 1.** Polymerization of PUA resin

| | Radical series | Cation series |
|---|---|---|
| Main ingredient | Acrylate | Epoxy |
| Cure shrinkage | 5 ~ 10% | 2 ~ 4% |
| Curing inhibition of oxygen | O | X |
| After stopping UV exposure | Cessation of curing reaction | Continuous curing reaction |
| Heat-induced curing facilitation | X | O |
| Heat resistance | Normal | Good |
| Chemical resistance | Normal | Good |

**Table 1.** Characteristics of PUA resin

In the experiment, two PDMS (A, B) were used and imprint experiments were carried out using PDMS mold of PH (pillar honeycomb) pattern in which pillar structures were arranged in hexagonal arrangement. Figure 2 and Table 2 show the experimental methods and conditions.

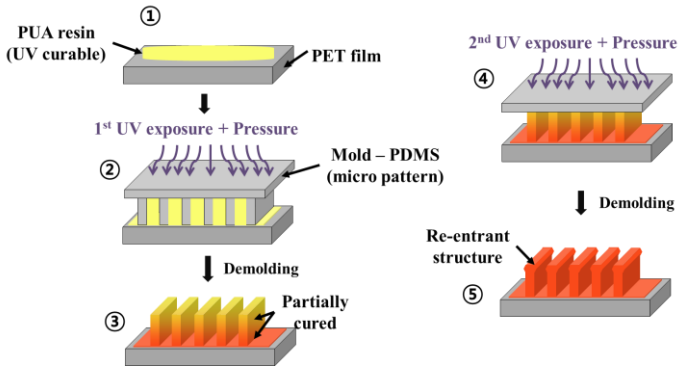


**Figure 2.** Process of imprint experiment

| PDMS | A, B |
|---|---|
| Micro pattern | PH (Pillar Honeycomb)<br>- Diameter : 10 μm<br>- Height : 20 μm<br>- Pitch : 40 μm |
| Resin | PUA resin (UV curable) |
| 1st curing | 15 s, 18 s |
| 2nd curing | 5 s, 10 s, 15 s |

**Table 2.** Experimental conditions

The experimental results were reviewed by SEM images and contact angle measurements. Figure 3 shows that the lower part of the pattern was deformed by the pressure during imprint

experiment as a result of using PDMS A. This shows the result of the reversed phase of the re-entrant structure. As a result of experiments using PDMS B, Figure 4 identified a pattern deformation whose upper part of the pattern was wider than the lower, as defined by re-entrant structure.

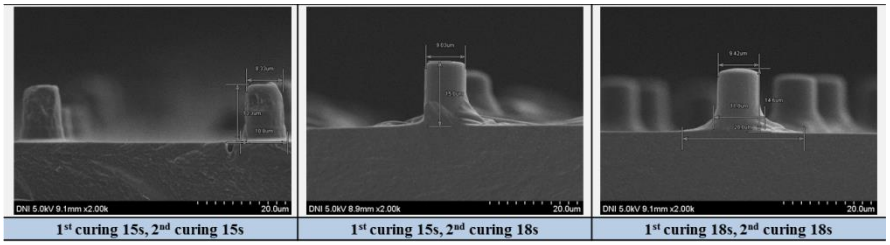


**Figure 3.** Experimental result (PDMS A)

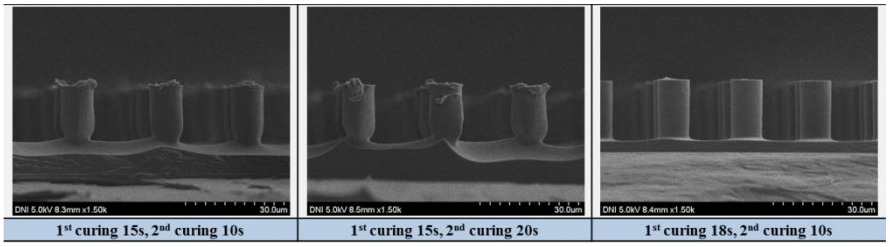


**Figure 4.** Experimental result (PDMS B)

The results of comparing the contact angles of the re-entrant structure produced by imprint experiment with the common pillar structure can be found in Figure 5. In the pillar structure, the contact angle was 98 ° when the surface treatment was not performed and 112 ° when the surface treatment was performed to increase the hydrophobic. Whereas, the contact angle measurement results of the re-entrant structure was 155.7 °, 157.2 °, and 163.8 ° even though the surface treatment was not performed. With this, to confirmed the excellent super-hydrophobic of the re-entrant structure.

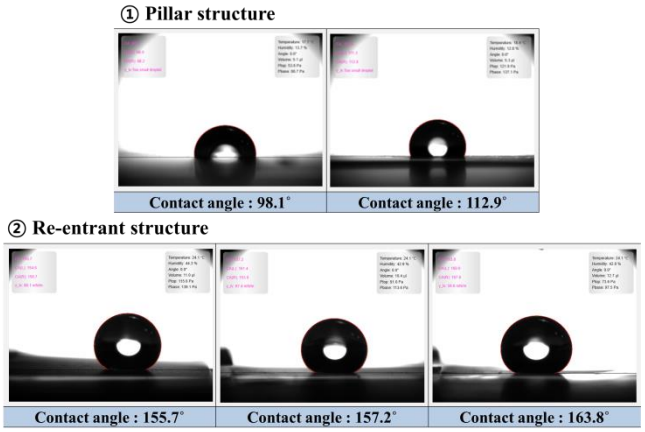


**Figure 5.** Measurement result of contact angle

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