Electronic Supporting Information (ESI)

Toward a disposable low-cost LOC device: heterogeneous polymer micro valve and pump fabricated by UV/Ozone-assisted thermal fusion bonding

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Characterization of the Bonding Strength

Peel off test

Since the UV/O_3 treatment provided a significant effect on the bonding between PP and PMMA, the bonding strength was characterized according to the conditions for the surface treatment time and the bonding temperature. To measure the bonding strength between PP and PMMA, a standard peel test was conducted by a universal tensile(UT) machine (UTS, Instron. Inc., USA). Following the ISO 90° peel test instructions,[1] PP specimens were prepared with 2 cm wide and 10 m long, and one side of the PP film was bonded to the PMMA substrate. After the PMMA substrate was firmly fixed to the UT stage, the other side of PP film was clipped to the UT, as pictured in **Fig. S1**.

While the PP film was pulled upward by the UT, the tensile force was recorded by the load cell at the clip of the UT, as shown in **Figs. S2** and **S3**. The bonding strength was collected from the measured data, while the PP film was detached from the PMMA substrate. When the bonding strength was too strong, the middle part of the PP film was torn apart and the bonded region was not detached from the PMMA substrate. In this case, the tensile force was abruptly dropped to 0 N/mm, as displayed in **Fig. S3 (c)** and **(d)**. For each bonding conditions, the peel tests were performed three times to attain the statistical precision.

To achieve an appropriate bonding strength for the geometry-selective bonding, the bonding condition was characterized by measuring the bonding strength in terms of the bonding temperature and the UV/O_3 treating time. In these tests, the bonding pressure and the bonding time was set 1 ton and 5 min, respectively.

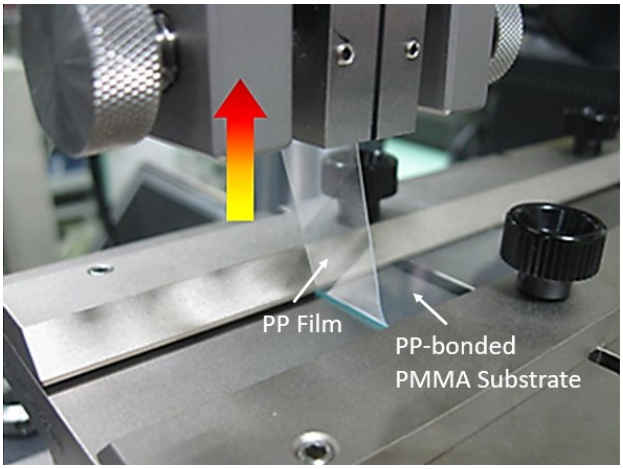


Fig. S1 Picture of the peel off test for measuring a bonding strength between PP film and PMMA substrate, which is fixed to a universal tensile (UT) machine (UTS, Instron. Inc., USA).

As shown in **Fig. S2**, the bonding strength was measured according to the bonding temperature. Prior to the bonding procedure, the bonding surface was exposed to UV/O_3 for 5 min. The bonding strength between PP film and PMMA substrate increased as the bonding temperature increased. Based on the characterization result, the appropriate bonding strength was achieved at the

temperature of 50 °C, and the bonding strength was saturated for the higher bonding temperature. Considering T_g of PP (110 °C) and PMMA (80 °C), an appropriate bonding between two heterogeneous materials was attained at much lower temperature than their T_g.

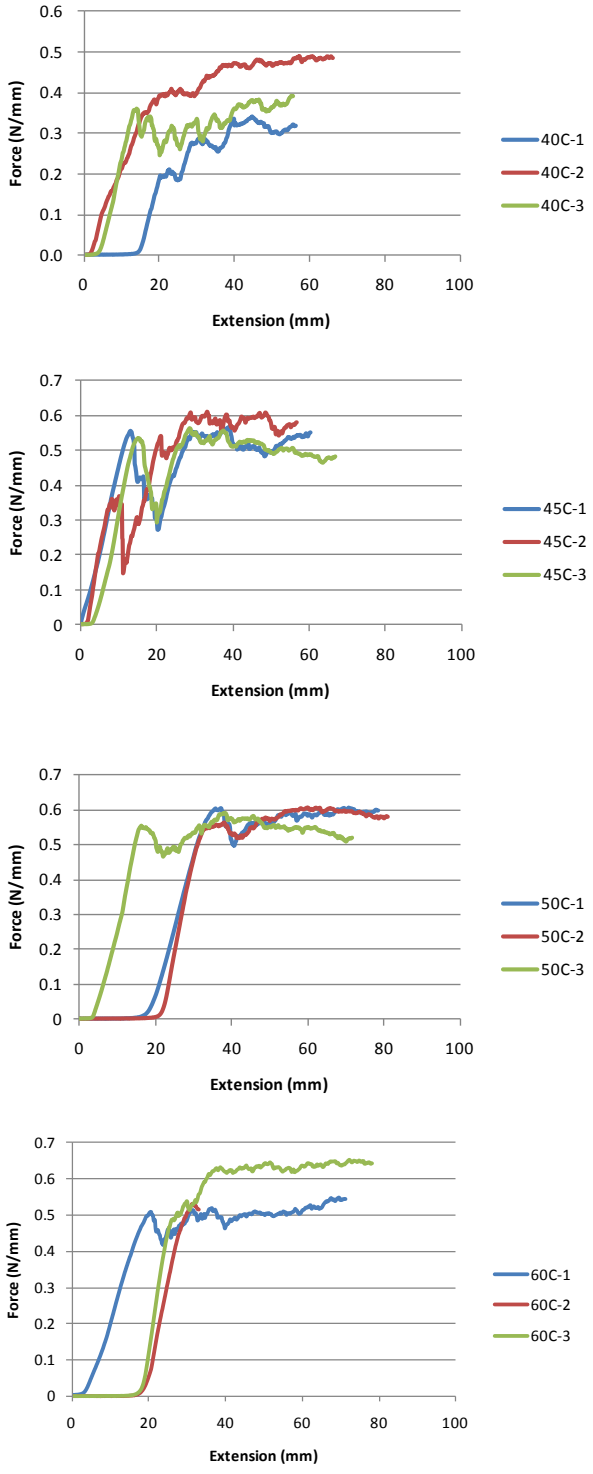
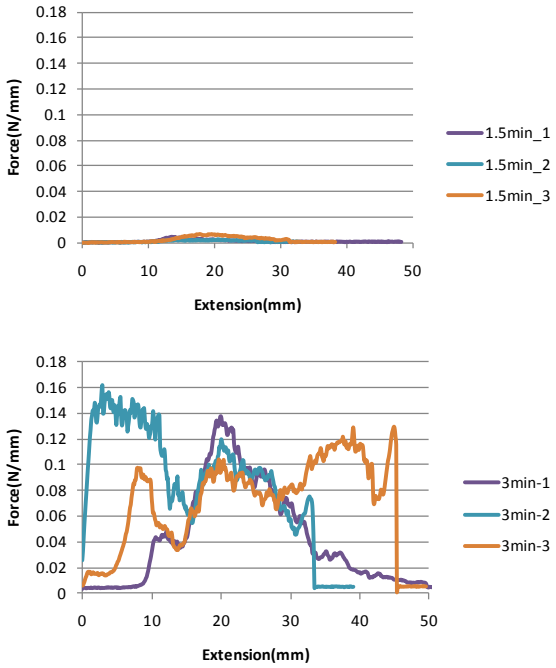


Fig. S2 Measurement of the bonding force according to the bonding temperature. (a) 40 °C, (b) 45 °C, (c) 50 °C, and (d) 60 °C.

After the characterization of the bonding temperature, the bonding strength was also measured according to the UV/O_3 treatment time. Based on the bonding temperature analysis, the bonding temperature was fixed to be 50 °C. **Fig. S3** shows the effect of UV/O_3 treatment on the bonding strength of PP and PMMA. The bonding strength sharply increased after 2 min of the UV/O_3 treatment. In addition, the bonding strength was saturated for the UV/O_3 treatment longer than 5 min. Based on these analyses, the bonding conditions were concluded to be 5 min of UV/O_3 treatment and 50 °C of bonding temperature. These bonding conditions provided a strong bonding between PP film and PMMA substrate, and minimized the deformation of thermoplastics to avoid the bonding of PP membrane to the PMMA valve seat.



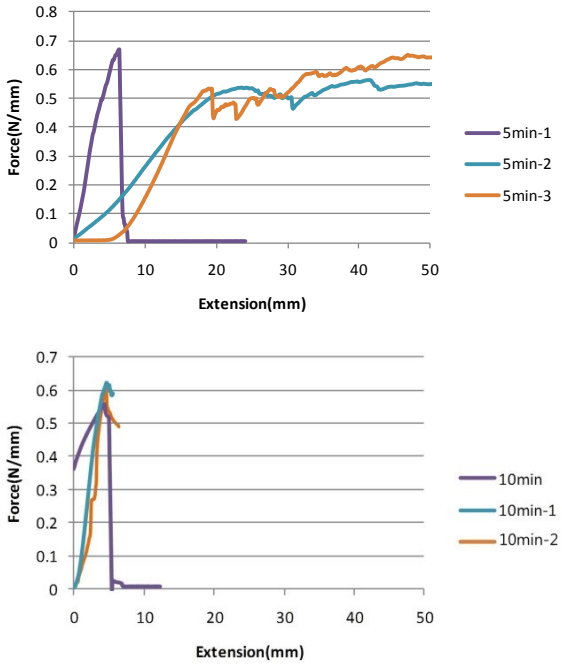


Fig. S3 Measurement of bonding force according to UV/O_3 exposure time. (a) 1.5 min, (b) 3 min, (c) 5 min, and (d) 10 min.

Notes and references

1. Adhesivess Peel test for a flexible-bonded 95 to-rigid test specimen assemblys Part 1: 90° peel; International Organization for Standardization: Geneva, 2006. https://www.iso.org/standard/43775.html (accessed on 02 January, 2020).