Data Article

Data from crosslinked PS honeycomb thin film by deep UV irradiation

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ABSTRACT

Thin polystyrene (PS) films with highly ordered honeycomb pattern were successfully fabricated by an improved phase separation method. The PS film was successfully crosslinked after applying a deep UV irradiation. This work presents a proof of crosslinking PS by characterizing ATR-FTIR, TGA and the wetting property of the honeycomb films, which were prepared using a solvent/non-solvent ratio of 90/10, before and after 6 h of UV irradiation.

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Specifications Table

| Subject area          | Physics, Chemistry  |
|-----------------------|---------------------|
| More specific subject area | Polymer honeycomb patterning film |
| Type of data          | Table, figure, image (scanning electron microscopy) |
| How data was acquired | Large-scale production of the patterning film was proved by the photograph of sample. The introduction of oxygen-containing functional groups was |

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confirmed through examining the Fourier transform-infrared (FTIR) spectra. The thermal property of the honeycomb film was characterized using TGA. The “disc-in-pore” topology was verified from SEM image. The wetting properties of honeycomb film were characterized by measuring water contact angle using a drop-shaped analyzer (Krüss DSA 100, Germany).

| Data format | Analyzed, tabulated and plotted |
|-------------|--------------------------------|
| Experimental factors | Chloroform/methanol volume ratio, humidity, temperature |
| Experimental features | The PS honeycomb film was prepared with chloroform/methanol ratio of 90/10 under ambient air environment (i.e. RH of 55% and temperature of 25 °C). The UV irradiation was lasted for 6 h. |
| Data source location | Chungnam National University, Deajeon, South Korea |
| Data accessibility | Data is provided with this article |

### Value of the data

- The photograph of the sample represents the possibility of large-scale, easy production of this method.
- ATR-FTIR and TGA analysis indicate that PS honeycomb film was successfully crosslinked after applying a deep UV irradiation.
- Water contact angle measurement is very simple and useful for characterizing the functionalized surface.

### 1. Experimental design, materials and methods

Experimental details are described in Ref. [1]. The honeycomb PS films used in this work were prepared with chloroform/methanol ratio of 90/10, and under ambient air environment.

The photograph presented in Fig. 1 demonstrates the potential for the proposed strategy to be expanded to large-scale production of honeycomb micropatterned films. By using the 2-step method, the large-scale polymer film with uniform thickness was firstly fabricated by taking advantages of a bar-coating technique. In comparision, the drop-casting technique, which is usually used in preparing

![Fig. 1. Photograph of a large PS film coated onto a copper substrate. The inset presents the highly ordered honeycomb structure of the PS film.](image)
honeycomb film by a BF method [2–6], is difficult in fabricating the uniform film, especially large-scale film, because the surface tension of the solution causes the lens shape of the droplet. The homogeneous sample color reflects the high uniformity of the patterned film, which was observed throughout the coated surface (∼30 cm²). For more insight into the geometry, the inset is SEM image, which demonstrates the highly ordered honeycomb structure of the PS film.

Fig. 2 shows the ATR-FTIR spectra of the PS honeycomb films before and after the 6 h UV irradiation. The aromatic C–C bonds and C–H bending vibrations of the benzene ring include three peaks of 1600, 1500, and 1400 cm⁻¹ [7]. After 6 h of UV irradiation, a broad band at 1750 cm⁻¹ appeared and it can be assigned as a C=O stretch of ketone groups. Thus, it indicates that oxygen was introduced into polymer matrix to form oxygen-containing functional groups.

The thermal property of the honeycomb films before and after applying UV treatment was characterized using TGA, as shown in Fig. 3. The as-prepared honeycomb PS thin film possesses both a glass transition temperature (∼110 °C) and the decomposition temperature, while the crosslinked film shows only decomposition temperature. This is a reason for the reservation of honeycomb structure after annealing crosslinked film at 250 °C.

For more insight into “disc-in-pore” structure after annealing, a 45° tilted SEM image of “disc-in-pore” film at a tear position is shown in Fig. 4. Discs with an average diameter of approximately

Fig. 2. ATR-FTIR spectra of the PS honeycomb films before and after the 6 h UV irradiation.

Fig. 3. TGA plot of the PS honeycomb films before (black) and after (red) the 6 h UV irradiation.
900 nm were located at the center of the pores and were separated from the honeycomb matrix by a gap of approximately 700 nm. This implies that the wafer-thin bottom layer inside the pore might be shrunk to form the “disc” at the center of the pore.

From a macroscopic perspective, the apparent contact angle was typically used to qualify the surface wettability, which is governed by the surface roughness and surface chemistry. The surface morphology of honeycomb film is almost not changed after UV treatment. Thus, the change of water contact angle after applying UV irradiation can be assigned to the change of surface chemistry. Table 1 shows the water contact angle of the PS honeycomb films before and after the 6 h UV irradiation. After UV irradiation, the water contact angle decreases considerably. It means that polar groups were introduced on the surface of honeycomb film after UV irradiation. The improvement of wettability of honeycomb film is favorable for the further applications such as cell culture and bio-sensors.

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**Appendix A. Supplementary material**

Supplementary data associated with this article can be found in the online version at http://dx.doi:10.1016/j.dib.2015.11.012.
References

[1] V.-T. Bui, H.S. Lee, J.-H. Choi, H.-S. Choi, Highly ordered and robust honeycomb films with tunable pore sizes fabricated via UV crosslinking after applying improved phase separation, Polymer 74 (2015) 46–53. http://dx.doi.org/10.1016/j.polymer.2015.07.056.

[2] H. Bai, C. Du, A. Zhang, L. Li, Breath figure arrays: unconventional fabrications, functionalizations, and applications, Angew. Chem. Int. Ed. 52 (2013) 12240–12255. http://dx.doi.org/10.1002/anie.201303594.

[3] M. Hernández-Guerrero, M.H. Stenzel, Honeycomb structured polymer films via breath figures, Polym. Chem. 3 (2012) 563–577. http://dx.doi.org/10.1039/C1PY00219H.

[4] L.-S. Wan, L.-W. Zhu, Y. Ou, Z.-K. Xu, Multiple interfaces in self-assembled breath figures, Chem. Commun. 50 (2014) 4024–4039. http://dx.doi.org/10.1039/C3CC49826C.

[5] L. Heng, B. Wang, M. Li, Y. Zhang, L. Jiang, Advances in fabrication materials of honeycomb structure films by the breath-figure method, Materials 6 (2013) 460–482. http://dx.doi.org/10.3390/ma6020460.

[6] U.H.F Bunz, Breath figures as a dynamic templating method for polymers and nNanomaterials, Adv. Mater. 18 (2006) 973–989. http://dx.doi.org/10.1002/adma.200501131.

[7] L. Li, C. Chen, A. Zhang, X. Liu, K. Cui, J. Huang, et al., Fabrication of robust honeycomb polymer films: a facile photochemical cross-linking process, J. Colloid Interface Sci. 331 (2009) 446–452. http://dx.doi.org/10.1016/j.jcis.2008.11.053.