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Evaluation of Transparent Polyimide Film as a Biological Cell Culture Sheet with Microstructures

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1. Introduction

Polymer materials are often used in the preparation of cell culture sheets,[1] and polymer substrates with fabricated microstructures have been reported to support the culture of biological cells.[2,3] Polyimide (PI) has superior heat resistance, mechanical strength, and chemical stability. Therefore, PI is expected to withstand the high temperature of sterilization processing, and PI-based microstructures have been shown to be transferable by hot embossing that is suitable for MEMS fabrication processes.[4] However, conventional PI is not transparent and has an opaque tan color, which makes it difficult to observe cells cultured on PI sheets. Therefore, we focused on transparent PI, which has recently become available in the market.[5] In this study, we fabricated microstructure-containing cell culture sheets from transparent PI, and we cultured stromal marrow cells (OP9) on the sheets. For comparison, we also fabricated sheets with microstructures from parylene (PA) and polyetheretherketone (PEEK). Hot embossing was used to fabricate microtrenches with a width and depth of 5 μm on the polymer substrates.

2. Experimental results

The hot embossing fabrication methods are described in Fig. 1. The substrate polymer materials and the Si mold were heated beyond the glass transition temperature. The mold was then pressed onto the substrate, and it was released after cooling. The hot embossing time was 180 s, and a molding pressure of 400 Pa was applied to an area of 4 cm^2. The molding temperatures were 300°C for transparent PI, 260°C for PA, and 180°C for PEEK, respectively.

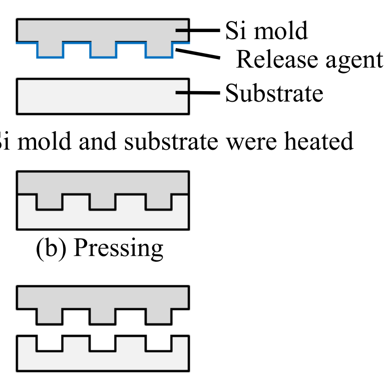

Fig. 1. Fabrication process for cell culture sheets

The polymer sheets underwent dry heat sterilization for 60 minutes at 120 °C. OP9 cells were washed in phosphate-buffered saline twice to remove serum ingredients. Attachment-enhancing proteins were digested by trypsin, and the cells were placed in a CO_2 incubator to maintain the pH. The sterilized cell culture sheets were placed onto a nutrient medium. The OP9 cells were seeded on the sheets, placed in the CO_2 incubator, and cultured for 24 h. The cells on the sheets were evaluated optically. No special surface treatment was applied, and the surfaces of these polymer sheets were used as received from manufacturer. OP9 cells were successfully cultured on the transparent PI sheet and PA sheet, but not on the PEEK sheet (Fig. 2). Because the PI and PA sheets were transparent, the cultured cells were easily observed using an optical microscope.

Figure 3 shows the contact angles between these polymer films and DI water. The surfaces of the transparent PI and PA were sufficiently hydrophobic to culture OP9 cells, whereas the PEEK sheet was not.

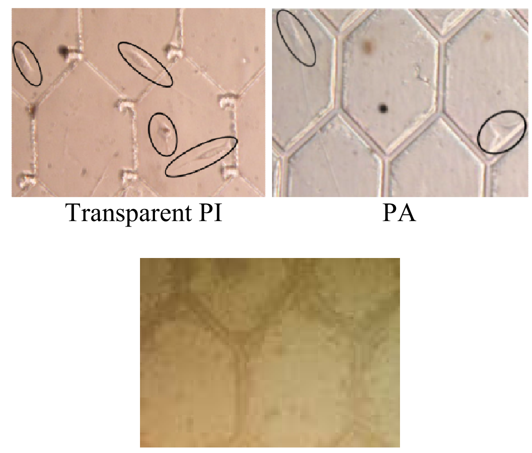

Fig. 2. Culture result for each material

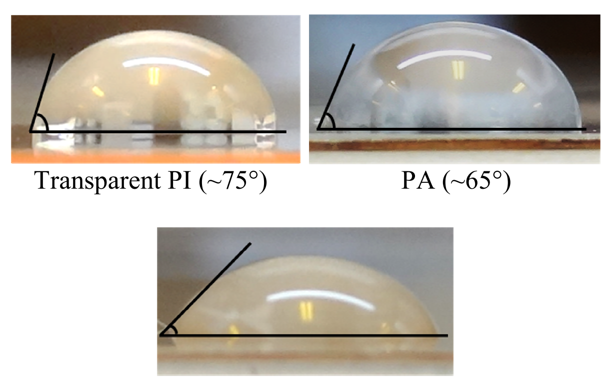

Fig. 3. Contact angle between DI water and substrates

3. Conclusion

We evaluated a transparent PI film as a cell culture sheet in comparison with films of PA and PEEK formed, which have been previously used in cell culture sheets. We fabricated microtrenches with a width and depth of 5 μm on these polymer films by hot embossing, and then cultivated OP9 stromal marrow cells on the sheets. The cells grown on the transparent PI were easily observed using an optical microscope.

References

[1] J. L. Charest et al., Biomaterials, 25 (2006), 2487.
[2] S. Taqvi et al., Biomaterials, 27 (2006) , 6024.
[3] J. L. Charest et al., Biomaterials, 25 (2004), 4767.
[4] H. Komatsuzaki et al., Jpn. J. Appl. Phys., 50 (2011), 06GM09.
[5] Product name of Neopulim L, (Mitsubishi Gas Chemical Company), INC, (http://www.mgc.co.jp/eng/index.html).