Effect of Plasma Treatment and Surface Coating on Cell Migration Dynamics

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The surface chemistry of material in contact with cells could affect cell motility. Polydimethylsiloxane (PDMS) is a widely used biocompatible material in many biological applications. However, the intrinsic hydrophobicity of PDMS is undesirable for cells. Previous research demonstrated that behavioral changes in cell migration could be observed due to modification of surface topography.[1] In this study, a two-layer scaffold platform was designed to separate the nasopharyngeal carcinoma (NPC43) cells from epithelial (NP460) cells. NPC43 cells had a higher probability to move from the top layers to the bottom layers through narrow trenches, while NP460 cells were less likely to squeeze into the trenches. After modifying the scaffold platforms by various plasma and chemical treatments, the separation efficiency between NPC43 and NP460 cells was enhanced to 99.4%.

As shown in Fig. 1, the two-layer scaffold platforms, consisting of two overlaying gratings with 40 μm wide ridges, 10 μm wide and 15 μm deep trenches, were fabricated by microfabrication technology. Platforms were treated with O_2/N_2, O_2, and Ar plasma before cell seeding. In Fig. 2, O_2/N_2-treated platforms achieved the highest separation efficiency of 92.3% compared to the others. In addition to the plasma treatments, (3-aminopropyl)triethoxysilane (APTES), fibronectin (FN), and APTES + FN were coated on the entire platform, as well as coating FN on the bottom layers. Selectively FN-coated platforms had the highest separation efficiency of 76.2%. Chemical coatings could increase NPC43 and NP460 cell migration into the 10 μm wide trenches. A narrower trench size of 5 μm was designed to reduce the probability for NP460 cells to move into the top layer trenches, hence increasing the separation efficiency. Figure 3 shows that NP460 cells moved faster on platforms with 5 μm wide top layer trenches, and the separation efficiency increased from 76.2% to 90.5%. Moreover, by lowering the concentration of FN coated on the bottom layer to 10 μg/ml, a very high separation efficiency of 99.4% was obtained.

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[1] S. F. Zhou, S. Gopalakrishnan, Y. H. Xu, S. K. To, A. S. Wong, S. W. Pang, and Y. W. Lam (2017). "Substrates with patterned topography reveal metastasis of human cancer cells," *Biomed. Mater.*, *12*(5), 055001.

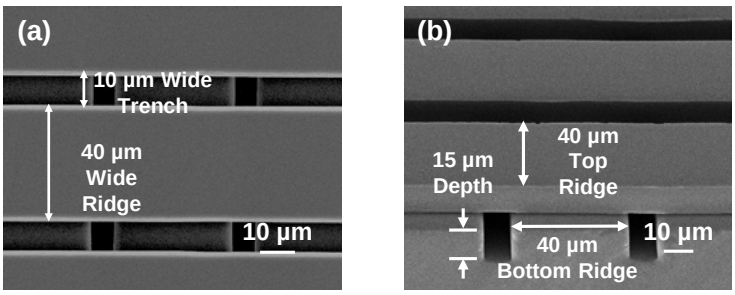

Figure 1: Micrographs of (a) top and (b) side views of two-layer scaffold platforms with 40/10 μm wide ridge/trench (R/T) gratings.

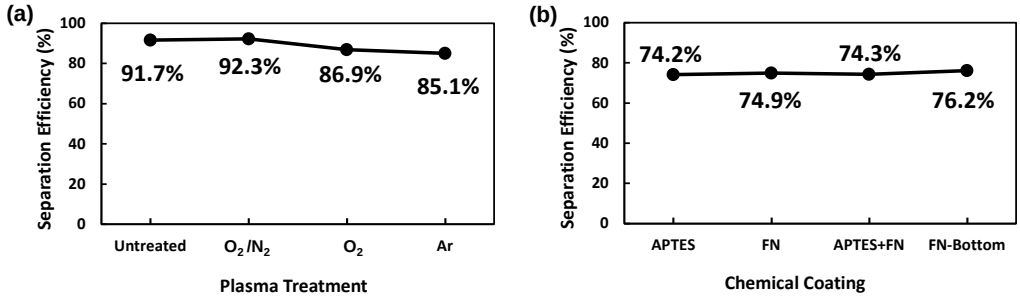

Figure 2: Separation efficiency of NPC43 and NP460 cells on (a) plasma-treated and (b) chemically-coated scaffold platforms.

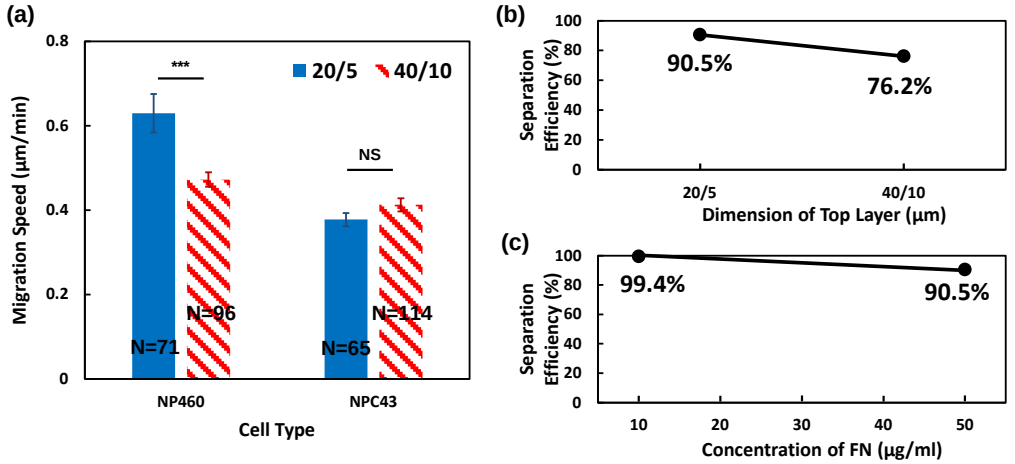

Figure 3: (a) Migration speed and (b) separation efficiency of NPC43 and NP460 cells on scaffold platforms with 20/5 and 40/10 μm wide R/T with FN coated only on bottom layers. (c) Separation efficiency of NPC43 and NP460 cells on platforms with 5 μm wide top layer trenches and FN coated on the bottom layers with different concentrations. One way ANOVA with Tukey's post-hoc test, ***p <0.001, NS – not significant.