Supporting Information

Effects of nanopillar array diameter and spacing on cancer cell capture and cell behaviors

Shunqiang Wang,[a] Yuan Wan*[bcd] and Yaling Liu*[ae]

[a]Department of Mechanical Engineering & Mechanics, Lehigh University, Bethlehem, PA 18015, USA. E-mail: yal310@lehigh.edu

[b]Ian Wark Research Institute, University of South Australia, Mawson Lakes, Adelaide, SA, 5095, Auatralia; [c]Department of Oncology, The Second Hospital of Nanjing, The Second Affiliated Hospital of Southeast University, Southeast University, Nanjing, Jiangsu 210003, China; [d]PMR Institute, Zhangjiang, Shanghai, 201203, China. E-mail: yuan.wan@unisa.edu.au

[e]Bioengineering Program, Lehigh University, Bethlehem, PA 18015, USA

S1. Calculation of maximum displacement of One Individual NP

For one individual NP with diameter of 120 nm, it endures both focal complex force (0.8-0.9 $nN/\mu m^2$)[1] and ligand-receptor bond force ($6.7\times10^{-6}\,dyn$ for one bond)[2]. Focal complex force was applied in the top surface of NP and ligand-receptor bond force in both top surface and side wall. Following this boundary setup, an FEM study using Comsol software was pursued to study the maximal displacement.

S2. Study of Substrate wettability through Cassie's Law

In our NP substrate system, with the fact that the substrate surface was silicon dioxide which was hydrophilic, the Cassie's law gave the contact angle θ as $\cos\theta = f_1\cos\theta_1 + f_2\cos\theta_2$, where f_1 and f_2 are the fractions of the solid phase (namely packing density of NPs) and water phase which compose the entire surface, respectively. θ_1 and θ_2 are contact angles for the solid phase and water phase, respectively. Noticed $\theta_2 = 0$ for water phase. So the equation of contact angle θ were simplified as: $\theta = \arccos\left(f_1\cos\theta_1 - f_1 + 1\right)$.

S3. Selection Criteria for incubation time and shaking speeds

As shown in Fig. 2(a), incubation time ranging from 5 minutes to 2 hours was applied with 10 minutes' shaking in 60 rpm. It was observed that, for bare wafers with anti-EpCAM coated, capture yield increased with incubation time, reaching a plateau of 22.9% in 1 hour. No significant difference of capture yield was observed after 1 hour, with 23.1% and 24.4% for 90 minutes and 120 minutes, respectively. Rare capture for bare wafer with 1% BSA coated verified that capture of PC3 cells in anti-EpCAM group was induced by specific bonds between PC3 cells and anti-EpCAM. Moreover, aim of this work is to study cell capture other than cell

adhesion/migration, so that focal adhesions fully established in around 1 hour[1] was not considered in our case. Timescale of 1 hour was also widely adopted in other relative work.[3] With these, 1 hour of incubation was applied for all the following studies. As shown in Fig. 2(b), shaking speeds ranging from 60 rpm to 400 rpm were applied after 1 hour's incubation. The relationship between maximum orbit shear stress and shaking speed was expressed as: $\tau_{o\max} = a\sqrt{\eta\rho(2\pi f)^3}$, where, a and f are orbit radius (0.95 cm) and frequency (rotation/sec depending on shaking speeds) of the rotation of the shaker, respectively; η (0.90 mPa·s) and ρ (0.995 g/mL) are dynamic viscosity and density of the medium, respectively[4]. As such, shaking speed between 60 rpm and 400 rpm corresponds to orbit shear rate between 157.3/s and 2708/s, which covered the majority range reported in literature: 267/s-1067/s [5] and 83/s-1166/s [6]. As expected, due to increased shear stress, capture yield decreased with increasing shaking speed and the biggest capture yield was obtained in the shaking speed of 60 rpm. The calculating shear stress of 0.24 dyn•cm^{-2} in 60 rpm was also observed to achieve more than 95% capture yield in a previous study.[6] Rare capture for bare wafer with 1% BSA coated again verified that capture force was generated by the specific bond between PC3 cells and anti-EpCAM. It also indicated that 60 rpm was enough to elute suspended cells. As a result, the optimal shaking speed of 60 rpm was adopted for all the following studies.

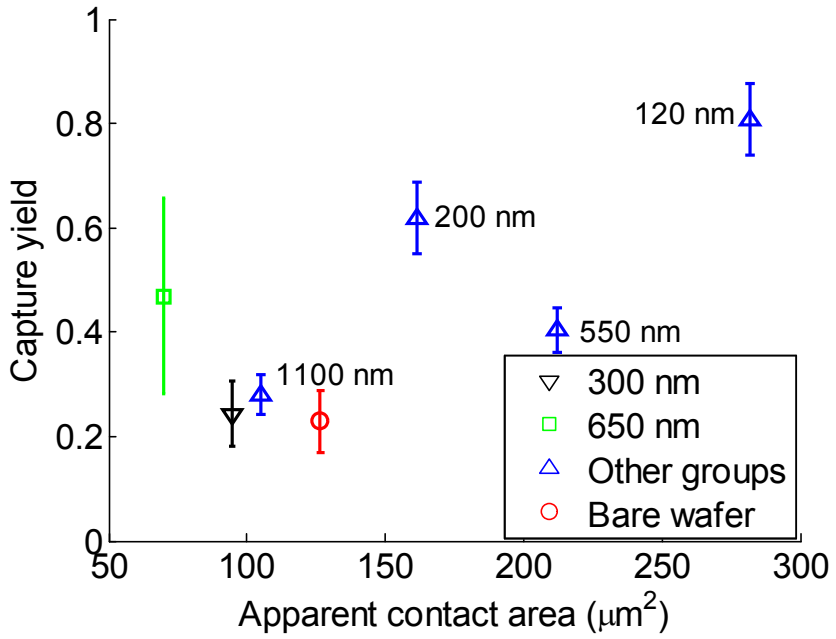

Fig. S1 Capture yield in terms of different apparent contact area

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