Supporting information

Evaluation of bacterial adhesion strength on phospholipid copolymer films with antibacterial ability by microfluidic shear devices

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SI. 1 Calculations for shear stress at the bottom of the channel

The movement of fluid in the physical domain is directed by governing equations, among which the Navier–Stokes equations[S1] are widely applied mathematical models to describe the flow properties during dynamic and/or thermal interactions.

$$\rho\left[\frac{\partial \Delta\vec{V}}{\partial t} + (V.\nabla)\vec{V}\right] =- \nabla p + \mu\nabla^2\vec{V} + \vec{\rho g}. \qquad Eq.S1$$

Eq. S1 is an expression of the Navier–Stokes equations, where ρ is the density of the fluid, V is the velocity of the fluid, t is the time, p is the pressure of the fluid, and g is the gravitational acceleration. In this study, the PBS was moved along a rectangular channel with a width (w) of 4.2 mm, a height (h) of 0.5 mm, and a length (L) of 42 mm. The Navier–Stokes equation can be extended as:

$$\rho\left(\frac{\partial\Delta\vec{V}}{\partial t}+V_x\frac{\partial V_x}{\partial x}+V_y\frac{\partial V_x}{\partial y}+V_z\frac{\partial V_x}{\partial z}+V_x\frac{\partial V_y}{\partial x}+V_y\frac{\partial V_y}{\partial y}+V_z\frac{\partial V_y}{\partial z}+V_x\frac{\partial V_z}{\partial x}+V_y\frac{\partial V_z}{\partial y}+V_z\frac{\partial V_z}{\partial z}\right)$$
$$=-\frac{\partial p}{\partial x}-\frac{\partial p}{\partial y}-\frac{\partial p}{\partial z}+\mu\left(\frac{\partial^2 V_x}{\partial x^2}+\frac{\partial^2 V_x}{\partial y^2}+\frac{\partial^2 V_x}{\partial z^2}+\frac{\partial^2 V_y}{\partial x^2}+\frac{\partial^2 V_y}{\partial y^2}+\frac{\partial^2 V_y}{\partial z^2}+\frac{\partial^2 V_z}{\partial x^2}+\frac{\partial^2 V_z}{\partial y^2}+\frac{\partial^2 V_z}{\partial z^2}\right)+\rho\vec{g}.\qquad Eq.S2$$

As fully developed fluid moves along the microchannel, $V_y=V_z=0$ and $\frac{\partial p}{\partial y}=\frac{\partial p}{\partial z}=0$. In this situation, V_x is the only velocity component. The velocity did not vary with time at a; hence, $\frac{\partial\Delta\vec{V}}{\partial t}=0$. As $w\gg h$, the effect of the sidewall was negligible; therefore, the microchannel can be regarded as a parallel plate flow chamber wherein the fluid velocity did not vary along z-direction, $\frac{\partial V_x}{\partial z}=0$, and V_x is the function of *y* only, $\frac{\partial V_x}{\partial x}=0$. Finally, the channel was set horizontally such that the movement of the fluid is perpendicular to the gravitational force, $\vec{g}=0$. Therefore, the equation can be simplified as,

$$0=-\frac{\partial p}{\partial x}+\mu\frac{\partial^2 V_x}{\partial y^2}.\qquad Eq.S3$$

The medium moves along the *x* direction, $V_y=0$; therefore $-\frac{\partial p}{\partial x}=-\frac{dp}{dx}$, and $p=p(x)$.

V_x is a function of y only, implying $\frac{\partial p}{\partial x}=\mu\frac{\partial^2 V_x}{\partial y^2}=p'$ (constant).

After integrating twice, the resulting equation is,

$$V_x=\frac{p'}{2\mu}y^2+c_1y+c_2.\qquad Eq.S4$$

Based on the assumption that there is no slip condition at the solid surface, where $V_x=f(y)=0\ (y=\pm h/2)$,

$$V_x=\frac{p'h^2}{2\mu}\left(\frac{y^2}{h^2}-\frac{1}{4}\right).\qquad Eq.S5$$

The flow rate (Q) in the microchannel can be obtained as,

$$Q = \int_{-h/2}^{h/2} V_x(y) \cdot w = -\frac{P' h^3}{12\mu} \cdot w. \qquad Eq.S6$$

Therefore, $p' = -\frac{12\mu Q}{h^3 w}$ is obtained.

Next, plot for Poiseuille flow to calculate the shear stress.

$$\tau = \mu \frac{dV_x}{dy} = \mu \frac{p'}{\mu} y = -\frac{12\mu Q}{h^3 w} y \qquad Eq.\,S7$$

At the bottom of the channel, substituting $y = -h/2$ into *Eq. S7*, the shear stress can be expressed as:

$$\tau = \frac{6\mu Q}{h^2 w}. \qquad Eq.\,S8$$

SI. 2 Quartz crystal microbalance (QCM) measurement for fibrinogen adsorption

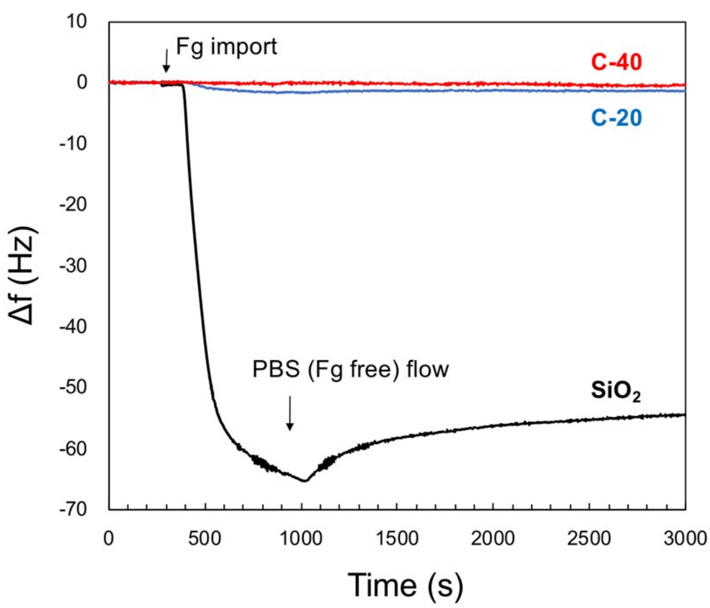

Figure S1. Result of the Fg adsorption on SiO_2, C-20, and C-40 surfaces measured by QCM. Δf (f in Hz) is the normalized frequency change by 7th overtone.

References

S1 F. White, *Viscous Fluid Flow*, McGraw-Hill Mechanical Engineering: 1991.