**Supplementary Material**

**Numerical approach-based simulation to predict cerebrovascular shear stress in a blood-brain barrier organ-on-a-chip**

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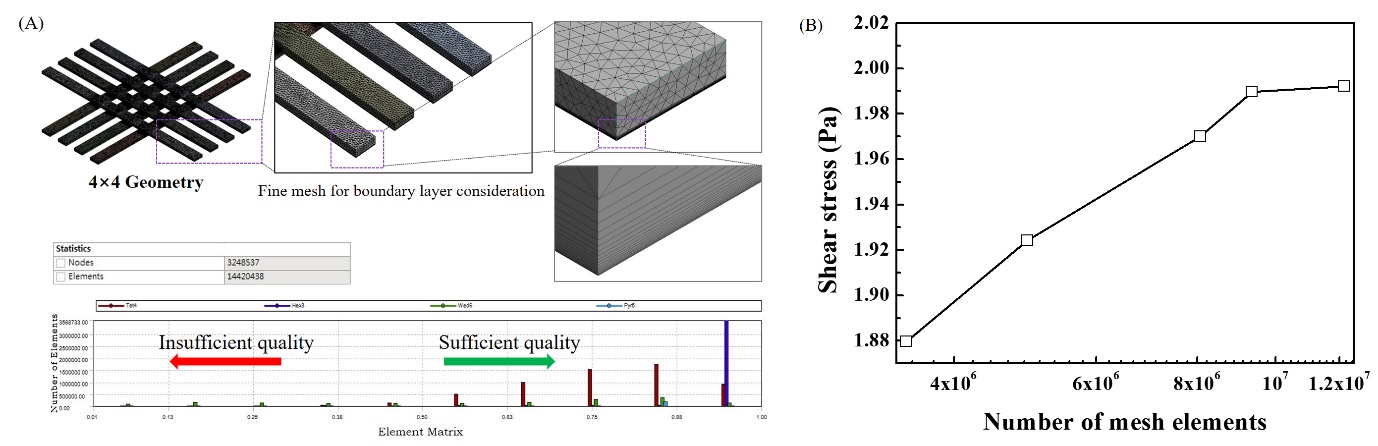


Figure S1. (A) Mesh setting for the microfluidic channel geometry. (B) Shear stress changes during the increase of mesh elements

Table S1. Summary of shear stress level and device features of the present BBB-on-chips.

|  |  |  |  |
| --- | --- | --- | --- |
| **Feature**  **Reference** | **Shear stress**  **(dyne/cm2)** | **Device materials**  **(from bottom to top)** | **Size of the blood compartment**  **(width × height)** |
| ([Booth and Kim 2012](#_ENREF_4)) | 0.0008 | Glass with electrodes - PDMS - PC - PDMS - glass with electrodes | 2 mm × 200 µm |
| ([Deosarkar et al. 2015](#_ENREF_12)) | 0.0038 | Glass – PDMS | 200 × 100 µm |
| ([Brown et al. 2015](#_ENREF_5)) | 0.02 | PDMS - PC - PDMS – PDMS | 6.2 mm × 100 µm |
| ([Prabhakarpandian et al. 2013](#_ENREF_23)) | 0.03 | Glass – PDMS | 200 × 100 µm |
| ([Walter et al. 2016](#_ENREF_28)) | 0.15 | Glass with electrodes - PDMS - PET - PDMS - glass with electrodes – PDMS | 200 × 200 µm |
| ([Sellgren et al. 2015](#_ENREF_24)) | 5 | PDMS - PTFE or PE – PDMS | 1 mm × 150 µm |
| ([Griep et al. 2013](#_ENREF_16)) | 5.8 | PDMS - PC – PDMS | 500 × 100 µm |
| ([Jeong et al. 2018](#_ENREF_17)) | 20 | PC with electrodes – PDMS – PC – PDMS – PC with electrodes | 1 mm × 300 µm |
| ([Yeon et al. 2012](#_ENREF_31)) | N.A. | Glass – PDMS | 25 µm high |
| ([Achyuta et al. 2013](#_ENREF_2)) | N.A. | Glass - PDMS - PC – PDMS | 10 mm × 100 µm |
| ([Cho et al. 2015](#_ENREF_9)) | N.A. | Glass - PDMS - acryl reservoirs | 50 µm high |
| ([Kim et al. 2015](#_ENREF_19)) | N.A. | Collagen in 3D printed frame | 235 ~ 360 µm diameter |
| The physiological shear stress in blood vessels is between 3-25 dyne/cm2 ([Kamiya et al. 1984](#_ENREF_18); [Wong et al. 2013](#_ENREF_30)).  “N.A.” indicates that a specific function has not been measured or reported. | | | |

Table S2 Properties and materials of various components of the BBB model

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Component | Density  (*kg/m3*) | Thermal conductivity  (*W/mK*) | Specific heat  (*kJ/kgK*) | Dynamic viscosity  (*Pas*) |
| Upper/Lower channels  (PDMS) | 0.97 | 0.15 | 1.46 | - |
| Membrane  (Polycarbonate) | 1200 | 0.19 | 1.2~1.3 | - |
| Fluid | 0.25 | 0.6 | - | 0.0018 |

Table S3 Details of boundary conditions used in numerical analysis

|  |  |
| --- | --- |
| Parameter | Value |
| Volume flow rate (μL/min) | 0.075, 0.375, 0.75, 1.125, 1.5, 1.875, 2.25 |
| Temperature (oC) | 37 |
| Viscosity (Pa.s) | 0.0018 |
| Porosity (%) | 0.01, 0.1, 1, 5, 10, 20 |
| Permeability (m2) | 1E-03 |

Table S4 Shear stress values which were applied to the developed model corresponding to various flow rates

|  |  |
| --- | --- |
| Flow rate (μL/min) | Shear stress (dyne/cm2) |
| 0.075 | 1 |
| 0.375 | 5 |
| 0.75 | 10 |
| 1.125 | 15 |
| 1.5 | 20 |
| 1.875 | 25 |
| 2.25 | 30 |

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