Supporting Information

Cellular Behavior Controlled by Bio-Inspired and Geometry-Tunable Nanohairs

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Numerical simulation of cell probability

We theoretically calculated the probability of cell movements on the nanostructures. We restricted the cell behavior to 1D structures and each structure is represented by their profile h_f, h_v, and h_s. h_f for a flat surface is always 0. h_v has two pollar structures with a maximum height of h_0 Their spacing is 500 nm (black) or 300 nm (gray). h_s is represented as an asymmetric sinusoidal pattern with two different heights depending on the stooped angle. Based on the geometry, the periodic external field was calculated as a potential energy *U(x)* and cell existent probability. [1] Based on the simulation results, morphology effects could be investigated. At vertical stimulation, density of hair structure was considered. When hairs are denser, cells are likely to survive on hair structure which can be verified by Fig. S1c (middle). Cells have higher probability when spacing is 300 nm rather than 500 nm. The degree of stooped shows how the stooped angle affects the cell behaviour. In Fig. S1c (right), probability difference for red line (more stooped) is smaller than black line (less stooped). It means the more hair stoopes, the more probability distribution is uniform and ultimately becomes flat. Considering these two phenomena, cell viability increases while hair stoopes and polarization of cell occures. However, in a certain critical point of angle, cell starts to lose its polariztion. Lenght and width of the hair can be also one of the aspects affecting the cell behaviour. We can easily expect that wider width offers larger contact area and increasing the cell viability. On the other hand, length has to be considered with other aspects such as width or material modulus since it determins the sturcture profiles by buckling or bending.

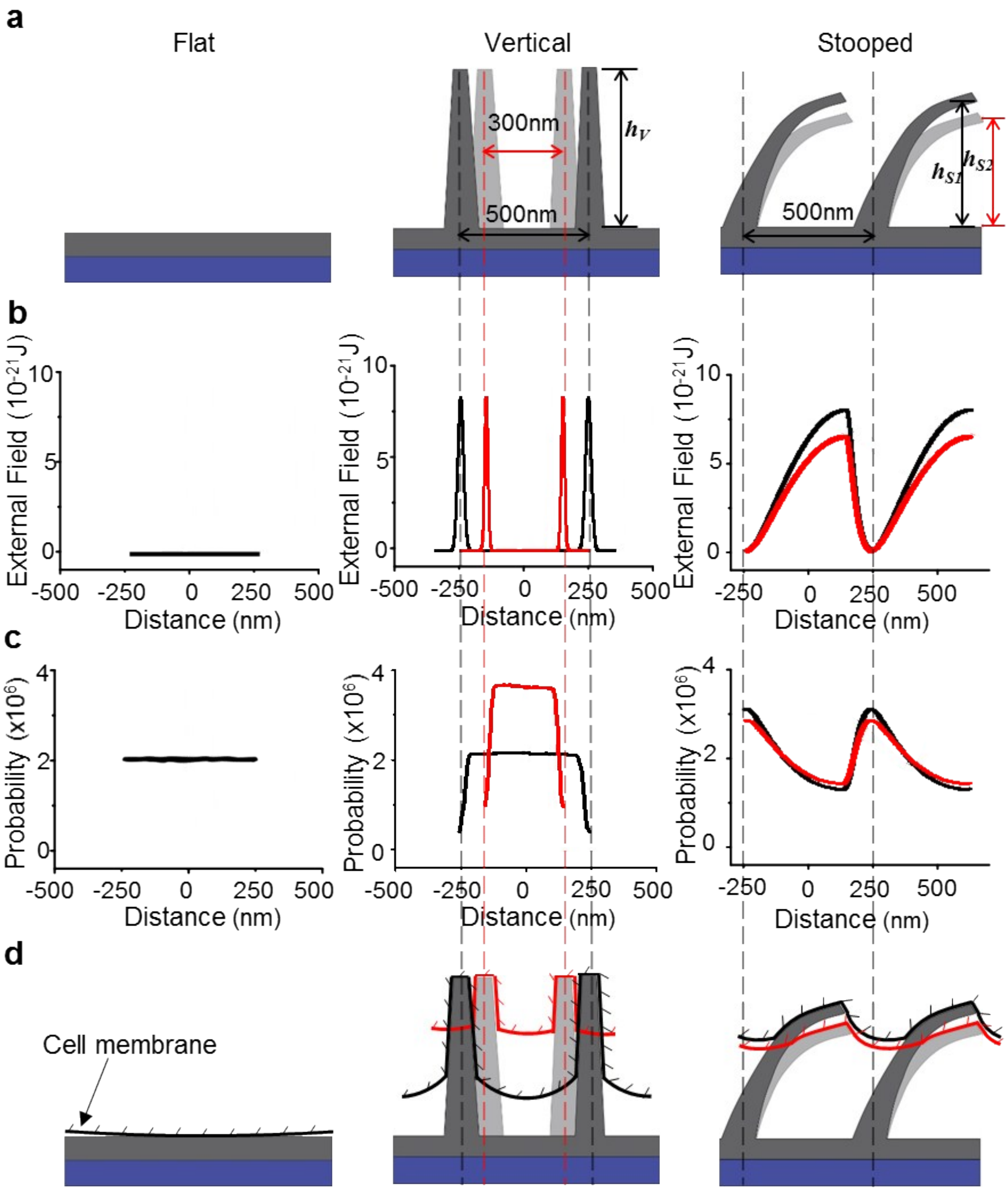

Fig. S1 (a) Schematic diagram of surface profile for flat, vertical, and stooped nanohair. (b) Potential energy field profile for each surface state. (c) Distribution probability of cell's existence for each surface state. (d) Cell surface shape merged on profile (a).

Durability test for humidity and mechanical stress

We performed the durability of the hair structured substrates on different conditions. For the humidity test, three extra condition was considered. Substrate manufactured in a rainy day (a), an hour of water sink without Pt coating layer (b) and with Pt coating layer (c). For mechanical stress effect, substrates were bended 1,000 times at 60 rpm with the 2 mm radius of curvature. With the 20 nm of Pt coating layer, no critical effects were observed.

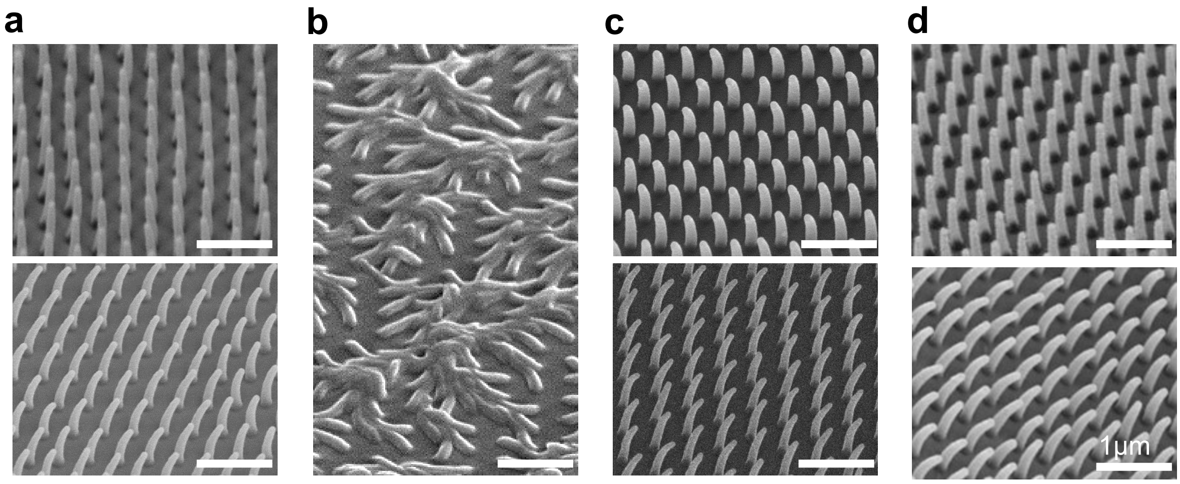

Fig. S2 SEM images of nanohairs tested by different conditions. (a) Exposed rainy day (about relative humidity ~80%), (b-c) immerged water (b) without and (c) with Pt layer for an hour. (d) Nanohairs under mechanical stress by 1,000 times bending with 2 mm radius of curvature.

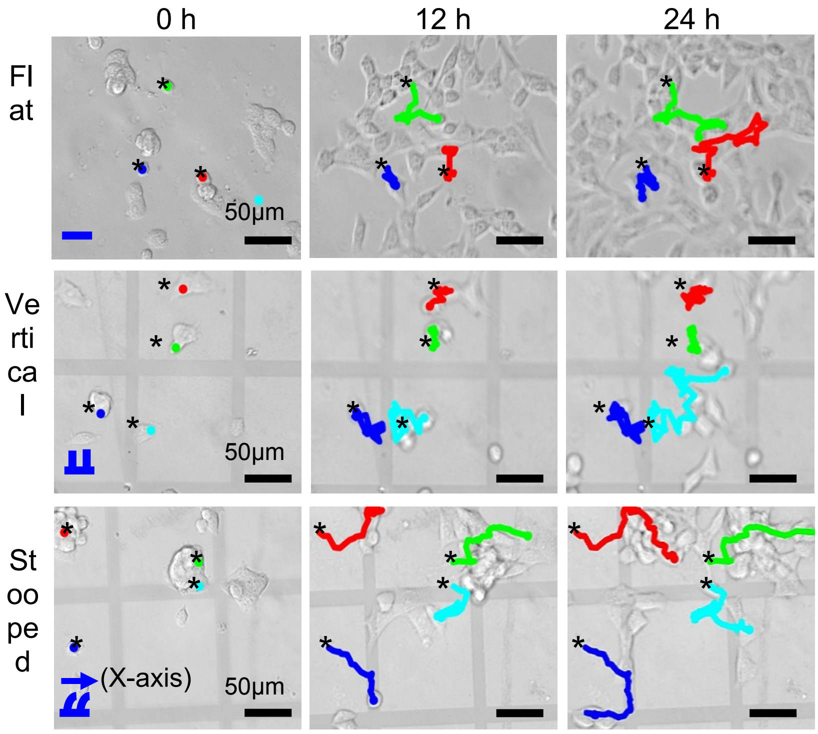

Fig. S3 Time-lapse optical images of neuronal cell migration patterns. The movement of several cells, marked with stars, were traced for 24 hours and overall migration track which are highlighted by colored lines from initial location (t = 0h) to final location (t = 24h) are indicated.

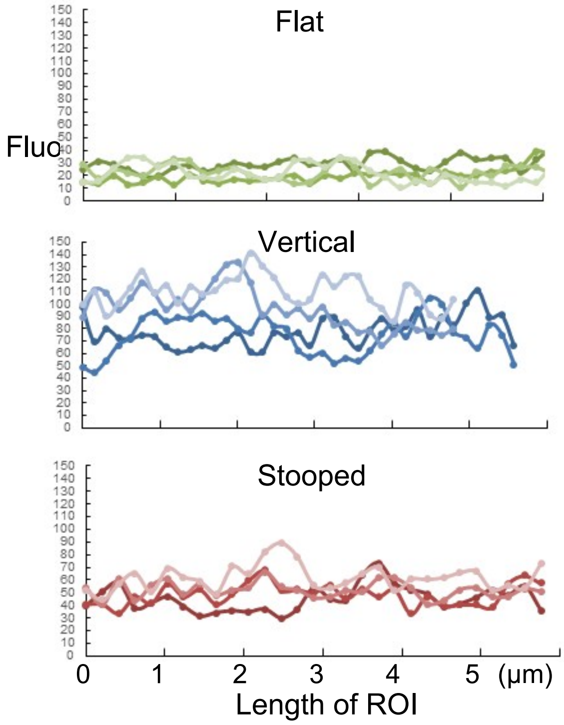

Fig. S4 Green fluorescence intensity profile of cells stained by F-actin-GFP antibody. Cells cultured on the flat, vertical, and stooped nanohair substrates. The length of the region-of-interest (ROI) for intensity analysis is 5 μm in the intracellular area on each substrate.

References

1 H. Risken and T. Frank, *The Fokker-Planck Equation ; Methods of Solution and Applications*, Springer-Verlag Berlin Heidelberg.