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Surface Shape Memory Substrates for the Study and Application of Mechanobiology

Substrates of defined topography or elastic modulus have emerged as powerful tools to direct cell alignment, adhesion, lineage specification, growth, and migration^{1,2}. These findings have underscored the potential for substrates to control and assay the mechanical interactions between cells and their physical environment during cell culture; however, the substrates used to date have generally been passive and could not be programmed to significantly change properties during culture. Shape memory polymers (SMPs) are a class of active materials that can be programmed to transition from a stable temporary shape to a permanent shape by a triggering mechanism, such as heat³. SMP substrates were developed that employ surface shape memory to provide programmed control of substrate topography. A substrate was prepared such that it could transition from a surface with micron-scale grooves (Figure) to a flat surface by transfer from a 30 °C to a 37 °C incubator. Cells cultured on these substrates reoriented after transition, and showed microfilament reorganization (Figure) while retaining high cell viability. These results introduce the use of SMP substrates for investigation of mechanotransduction, cell biomechanical function, and cell soft-matter physics. To read the full paper, see reference 4.

References

1. Tan, et al., Proc. Natl. Acad. Sci. U. S. A. 100, 1484-1489 (2003).
2. Engler, et al., Cell 126, 677-689 (2006).
3. Lendlein, et al., Expert Rev. Med. Devic. 7, 357-379 (2010).
4. Davis, et al., Biomaterials 32, 2285-2293 (2011).

Figure.

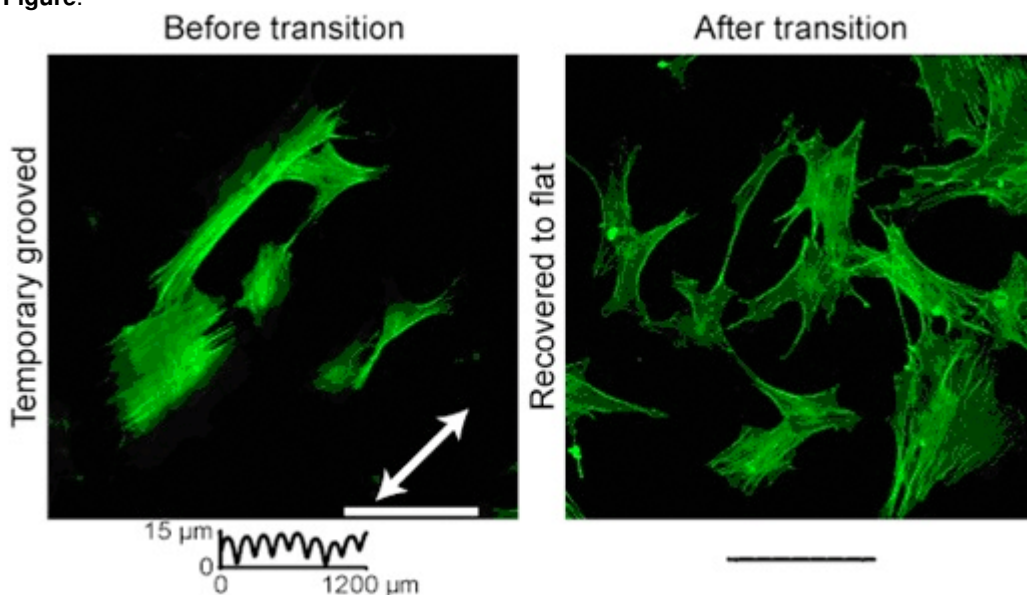


Figure Caption:

Confocal images of cells stained with phalloidin on a temporary grooved topography show microfilaments aligned with groove direction (white arrow) before transition and temperature increase. After transition, microfilaments have rearranged and are randomly oriented. Scale bar is 100 µm. Traces display representative profilometry traces of surface topography.