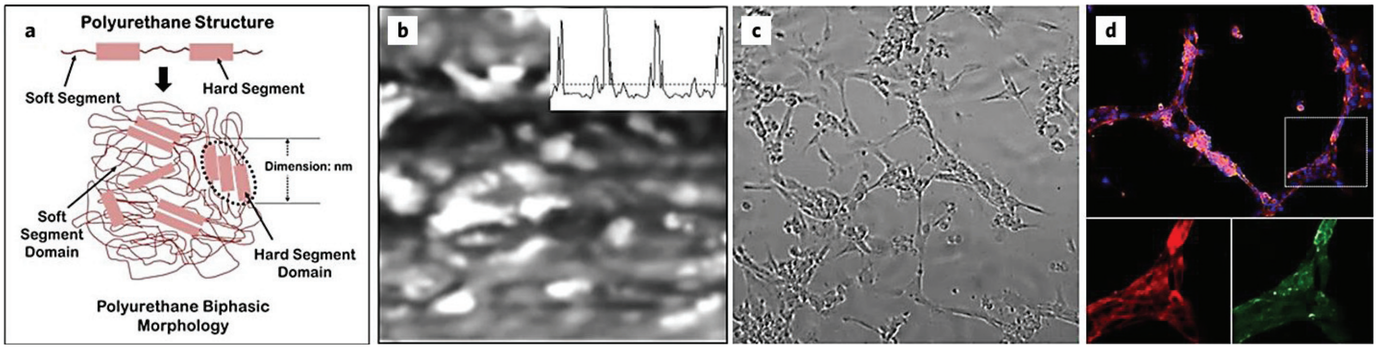
World Scientific   Imperial College Press

PRESS RELEASE

Phase morphology of segmental polyurethanes provides signals for endothelial cells to organize into networks

November 23, 2015 — This study demonstrates that role of nanostructured biphasic morphology of segmental polyurethanes as a matrix signal for organization of endothelial cells into network structures.



Polyurethane phase morphology induces endothelial cell organization. a) Segmental composition of polyurethane induces nanostructured phase morphology. b) Atomic force microscopic image of polyurethane phases. c) Endothelial cells organizes to form interconnected network like structure on polyurethane matrix. d) Endothelial networks are synchronized by balanced cell-matrix and cell-cell adhesion.

A group of researchers from the Biomaterials and Regenerative Therapeutics Laboratory in the Department of Biomedical Engineering at University at Buffalo has shown that nanostructured phases of segmental polyurethanes can guide endothelial cells into networks which are critical for initiating vascular structures in regenerative tissue engineering applications. This study has provided an interesting avenue to guide cells with the nanoscale domains of synthetic matrix which has not been perceived as a matrix cue for endothelial cell organization.

Cell-material interactions play a key role in regulating cellular function and organization during tissue regeneration and therefore controlling these interactions on synthetic matrices are crucial for successful tissue engineering. Particularly, endothelial cells require synchronized cell-matrix and cell-cell interactions to organize into networks for capillary tube formation. In contrast to current approaches either utilizes nano and microscale topographies or immobilized cell adhesive ligand to control cellular organization, this study has shown that material induced solid state phase morphology of matrix can provide cues to endothelial cells to form networks, even without any biological stimuli.

The main concept herein describes the significance of segmental polyurethanes which forms nanostructured domains as phases owing to the inter and intrasegmental interactions and these domains can guide the cells into networks. Using L-tyrosine based biodegradable and biocompatible polyurethanes, researchers have shown that polyurethane matrices display different phase morphologies depending on the segmental composition. The main concept was to utilize these nanodomains of polyurethane as matrix guided signal because natural extracellular matrix also exhibits self-assembled domains. When endothelial cells were cultured on 2D polyurethane matrices, the cells organized into interconnected networks on polyurethane matrices which displayed well defined segregated phases in nanoscale dimensions. In comparison, cells on phase-mixed polyurethanes were not able to form organized structures. Endothelial cells can sense the nanoscale features of polyurethane matrix and the nanostructured phases provided contact-mediated adhesive guidance to the cells to form interconnected structures.

This concept is significant because material driven phases provided signals for endothelial organization in absence of biological matrix or growth factors and it demonstrates the role of nanophase morphology as a critical regulator for cellular organization.

The future goal is to further characterize the phase morphology with defined nanostructures through modulating polyurethane structure and composition, establishing relationships between varying phase morphology and endothelial cell response, and investigating these responses in 3D scaffolds. Application of this material driven phase engineering presents an exciting new direction for development of tissue engineered synthetic matrices where cellular responses can be tuned with precise spatial and temporal control.

Corresponding author for this study in TECHNOLOGY is Professor Debanjan Sarkar, Ph.D., debanjan@buffalo.edu

---