Selective Adhesion of Primary Neurons and Schwann Cells on Carbon Nanotube/Polycarbonate Urethane Surfaces

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Introduction: Carbon nanotubes (CNTs) contain excellent physical properties such as intrinsic nano surface roughness and conductivity. They can be incorporated into chemically stable, non-degradable polymers such as polycarbonate urethane (PCU), for biomedical applications[1]. In this preliminary report, we demonstrate the selective adhesion of primary neurons and glial cells to distinct regions of varied material composition and nano-roughness on CNT/PCU composite substrates. These results suggests a promising material to control cell functions for healing neural damage using CNT based materials.

Methods: Highly dispersed CNTs (multi-wall CNT, Catalytic Materials, MA) were dispersed into an FDA approved polymer, PCU (PC-3575A, Thermedics, DE) using a sonicator (S1752, Fisher-Scientific, NH). CNT-PCU substrates were sterilized before cell culture using 70% ethanol and UV light exposure. Substrates were cultured with either Schwann cells or postnatal rat dorsal root ganglia (DRG), seeded at 3000 cells/cm^2. Samples were cultured at 37 °C and 5% CO_2 for 4 hours. Cells were fixed in 2% paraformaldehyde with 4% sucrose. Nuclei were stained with 1μg/ml DAPI (Invitrogen, CA). Samples were analyzed under fluorescence microscopy (DM IRB, Leica, IL) at 100x and the numbers of DAPI-stained nuclei in five random fields were counted. Data were analyzed statistically with a student's t-test using Excel software (Microsoft, WA).

Results/Discussion: The CNT/PCU composite regions contained CNTs covered by PCU, and their surfaces had increased nano-roughness relative to bare PCU regions. The cellular responses to the distinct regions of the substrates varied between neurons and glial cells. Results showed for the first time that more DRGs adhered to the CNT/PCU regions with higher nano-roughness compared to the bare PCU regions (Figure 1a). In contrast, fewer Schwann cells adhered to CNT/PCU composite regions compared to bare PCU (Figure 1b). These results suggest that primary neurons and Schwann cells can respond differently to varying degrees of surface nano-roughness.

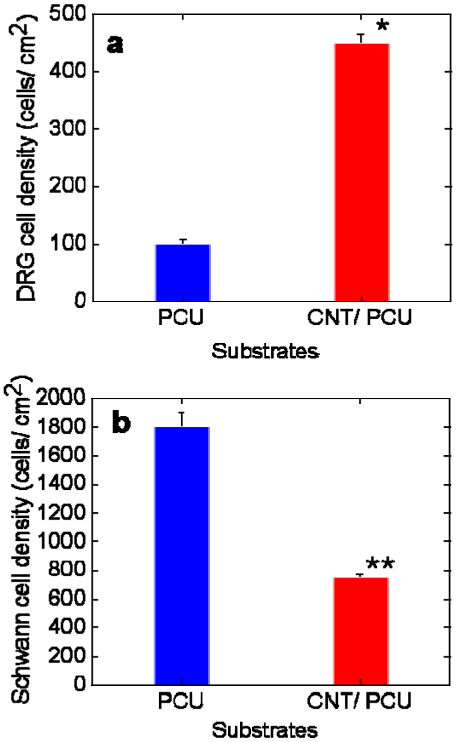

Figure 1. Selective adhesion of neuronal and glial cells to surfaces of different nano-roughness. a) Greater DRG cell densities on CNT/PCU than bare PCU. *$p<0.01$ compared to bare PCU. b) Lower Schwann cell densities on CNT/PCU than bare PCU. **$p<0.01$ compared to bare PCU. Error bars are SEM with n=3.

Conclusions: Selective adhesion of cells to specific regions of surfaces can allow the tailoring of materials for directing growth. Further investigation will focus on discerning the relative importance of nano-surface roughness and of inherent conductivity associated with the CNT/PCU materials. These results can be utilized for designing optimal nervous system biomaterial surfaces to guide axons for nerve regeneration, and to minimize scar tissue formation from damaged nervous system tissues.

References: 1) Webster TJ *et al*, Nanotechnology. 2004; 15: 48-54.