P.01 Mechanotransduction of deformable nano-structured elastic membrane surfaces on proliferation of osteoblast cells

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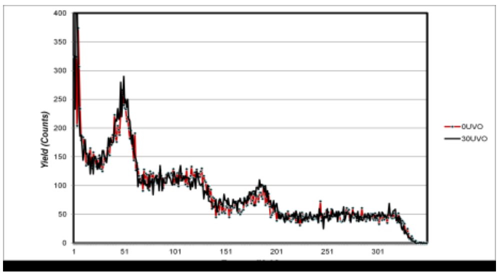
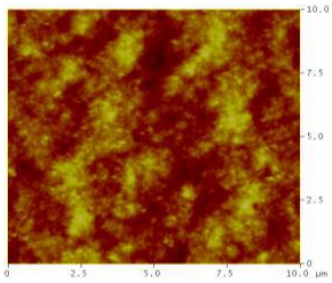
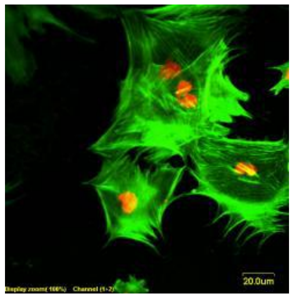
Bioactive substrates are capable of enhancing proliferation of osteoblast cells, since these cells transduce changes in the mechanical environment. This study investigates the effect of mechano-transduction through substrate characteristization on proliferation of osteoblasts-like (MC3T3-E1) cells. It is a fundamental study on the effect of mechanotransduction in bone cells through functionalised silastic bioactive nano-substrates. Strains occur in bone cells as a result of mechano-stimulus under physiological conditions [1] and the strain rate correlate with bone formation [2], since the mechanical forces are transmitted to cells through the ECM [3, 4] which results in immediate early gene expression and proliferation of MC3T3-E1 osteoblasts cells. Osteoblast cells were anchored to a chemically functionalized substrate to ascertain whether application of equibiaxial mechano-stimulus could change the cytoskeletal architecture of the cells. The membrane was functionalized, characterized using CA goniometry, RBS (fig. a) and AFM (fig. b). MC3T3-E1 cells were seeded onto the nano-scale biomimetic surface and subjected to mechanical deformation, after which cellular functions were evaluated, by CM, to determine changes in the cytoskeletal organization of the adherent cells. Application of biophysical forces to biological systems, according to Frost mechanostatic theory, translates into cellular responses, under physiological conditions; since cellular organisms tend to adapt to their mechanical environment. There were noticeable changes in the cytoskeletal architecture of MC3T3-E1 cells (fig. c) after subjecting them to the dynamic equibiaxial strains, with minimum cell damage, indicating that functionalised nano-surfaces transduced mechanical stimuli onto osteoblast-like cells. We engineered a system which mechanically transduces strains in nano-structured surfaces to enhance cytoskeletal architecture of osteoblast-like bone cells.



a) RBS data showing surface profile of membranes



b) AFM scans of radiated surfaces



c) CM-mechanotransduced MC3T3-E1 cells

[1] A. D. Bakker, K. Soejima, J. Klein-Nulend, and E. H. Burger. “The production of nitric oxide and prostaglandin E2 by primary bone cells is shear stress dependent”, Journal of Biomechanics. 34, 676 (2001)

[2] J. R. Mosley and L. E. Lanyon. “Strain rate as a controlling influence on adaptive modeling in response to dynamic loading of the ulna in growing male rats”, Bone. 23, 314 (1998)

[3] L. J. Wilson and D. H. Paul. “Functional morphology of the telson-uropod stretch receptor in the sand crab Emerita analoga”, Journal of Comparative Neurology, 296, 344 (1990)

[4] E. Ingbe. “Integrins as mechanochemical transducers”, Current Opinion in Cell Biology. 3, 844 (1991)