

Assessing Cell and Protein Interactions on Indium-Tin Oxide (ITO) for the Development of Cellular Biosensors and Artificial Biomaterials

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Cellular biosensors, comprised of whole living cells, have been used in various applications, including chemical screening for drug discovery and environmental sensing. However, biocompatibility remains an important problem for the successful development of such sensors. A detailed molecular understanding of cell-protein-materials interactions would assist the implementation of rational design of materials for the fabrication of such sensors.

We report here studies that elucidate cell and protein interactions on indium-tin oxide (ITO), a material with great potential for the fabrication of cellular biosensors. ITO was patterned with self-assembled monolayers (SAMs) of 3-(mercaptopropyl)triethoxysilane (MPS), 1-octadecanethiol (ODT), 3-mercaptopropionic acid (MPA), and aminopropyltriethoxysilane (APTES). The terminating groups of these SAM molecules (-SH in MPS, -CH₃ in ODT, -COOH in MPA and -NH₂ in APTES) lead to different surface properties. Contact angle measurements revealed that surface hydrophobicity increases in the following order: APTES, MPA < MPS < ODT. The electrochemical properties of the SAM-coated surfaces, with and without precoated fibronectin, were quantitatively analyzed in terms of impedance, using electrochemical impedance spectroscopy. The impedance of SAM-patterned ITO increases in the following order: ODT, APTES < MPA < MPS, and is higher than that of bare ITO. However, the difference in impedance decreases among the surfaces when fibronectin, an important extracellular protein for wound healing and cell adhesion, was deposited on the SAM-patterned surfaces. Morphometric analysis of 3T3 fibroblasts on SAM-patterned surfaces showed that the extent of cell spreading, as indicated by projected surface area, is the highest on APTES and MPS surfaces (relatively hydrophilic) and the lowest on ODT surfaces (relatively hydrophobic). The results suggest that physiochemical properties of underlying substrates are a major factor in affecting cellular response, which is an important parameter for the development of cellular biosensors.