Adhesion dynamics and organization of neurons and glial cells on nanocolumnar TiN substrates

Alice Abend[1], Chelsie Steele[1], Mareike Zink[1]

[1] *Research Group Biotechnology and Biomedicine, Peter Debye Institute for Soft Matter Physics, Faculty of Physics and Earth Sciences, Leipzig University, Linnéstraße 5, 04103 Leipzig, Germany*

Many biomedical applications such as deep brain stimulation with electrodes for neurodegenerative diseases like Parkinson's disease rely on fine-tuned coupling of biomaterials and biological tissue. Cell survival, proliferation, and biochemical function depend on the surface topography and chemistry at the interface between electrode and biological material. In addition to in vivo implementations, lab-on-a-chip devices such as multielectrode arrays offer new perspectives in in vitro assessments of cellular behavior ranging from neural network formation to drug testing by electrical coupling of the cells. In our study, we investigate the interaction of neurons (SH-SY5Y) and glial cells (U-87 MG) with electrode materials such as titanium nitride (TiN) and TiN with a nanocolumnar surface patterning in contrast to gold and indium tin oxide (ITO) substrates. TiN nano exhibits a lowered self-impedance important for miniaturization of multielectrode systems. Employing single-cell force spectroscopy, we analyze the short-term cell adhesion forces for different contact times on the electrode samples. Results are compared with measurements of cell proliferation, spreading dynamics, network building, and cluster formation on longer time scales of several days. To this end, we implement a radial autocorrelation function of cellular positions on the samples in combination with a K-means cluster algorithm to quantify cell-surface interaction and cell organization. Adhesion forces exerted by glial cells are almost independent of the electrode material and spreading dynamics stop after one day of culture with homogeneous cell distributions. In contrast, adhesion behavior of neurons varies with different substrate types and cells tend to spread more and form larger clusters on TiN and TiN nano. We conclude that TiN with a nanocolumnar surface patterning offers great potential as a bioactive material for building miniaturized microelectrode arrays in combination with neuronal cells.