VIBRATIONAL SUM FREQUENCY GENERATION STUDIES OF SELF ASSEMBLED MONOLAYERS ON GOLD FOR NEURON IMMOBILIZATION

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The significant challenge in the development of miniaturized biocompatible neuroprosthetic devices lies in understanding how neuronal networks grow on and interact with the implant surface.Self Assembled Monolayers (SAMs) have emerged as promising candidates for defining material features on miniature scales. To assess the suitability of SAMs for neuronal growth, we have investigated correlations of neuron adhesion with the chemical structure at the SAM surface characterized by Sum Frequency Generation (SFG) vibrational spectroscopy. SFG measurements were performed on three different types of SAMs: C_{11} amino terminated SAM, C_{11} carboxy terminated SAM, and 1:1 mixture, prepared on gold substrates with different surface roughness. The CH-stretch region is dominated by CH_2 stretch modes for all three SAMs regardless of the surface roughness, indicating significant amount of $gauche$ defects in the alkane chains. The frequencies of the methylene symmetric and asymmetric stretch transitions are close to those observed in liquid alkane chains. This also suggests that the monolayers are in a disordered liquid-like state. The C=O stretch region for carboxy terminated SAM shows one broad peak assigned to hydrogen bonded monomer COOH, 1767 cm^{-1}. Spectra of mixed amino: carboxy SAMs show transitions of both the COOH group and the asymmetric stretch of the COO^-, 1654 cm^{-1}, indicating partial ionization and homogeneous mixing without phase segregation of amino and carboxy terminated domains. Neuronal cell growth was monitored using Fluorescent Microscopic imaging, showing that only amino-terminated SAMs support growth of neuronal networks. A practical conclusion of this study is that the neuron adhesion is not critically affected by the surface roughness or details of the molecular ordering and orientation of the terminal amino groups, but only on the chemical functionality displayed at the surface.