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基于MONTE-CARLO模型的细胞传感器纳米颗粒表面处理分析

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摘　要：

离体生物传感器的微型和集成化为细胞电生理研究提供了有力手段。当前微电极阵列表面纳米粒子处理的相关量化分析尚为欠缺。本文着重采用Monte-Carlo模型判断单层/多层纳米粒子膜与电极耦合的有效性：讨论异质的单一或不同粒径分散度(50-500nm)的纳米粒子分层贴附处理于电极上，从二维、三维模型角度分析纳米粒子表面处理的有效性。多种结果显示，粒径分散度较大，且在一个数量级内的纳米颗粒能有效增大电极贴附率与处理均一性，以提高后期细胞-电极结合的重复性。相关金微阵列电极电镀的交流电阻抗实验也说明纳米颗粒的沉积对于降低电极体阻抗及增大表面活化处理的作用。表面处理技术的量化评估，有利于建立基于高通量平台的实验和计算生物学、信息处理技术有机结合的研究方法。

关键词：微电极阵列，细胞电生理，Monte-Carlo模型，纳米粒子，电极表面处理

Analysis of Surface Treatment with Nanoparticals on Extracellular Array Based on Monte-Carlo Model

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Abstract:

Microelectrode arrays in-vitro provide methods down to cellular level by micromation and integration. By now quantified evaluating analysis for electrode surface treatment is lacked and should be applied. In this respect, electrical properties of microarrays were analyzed by Monte-Carlo statistical model to demonstrate the surface immobilized effects. Different 2D and 3D models of nanoparticle-deposition were applied for single- /multi-layer on gold-disk-electrodes to analyze coupling efficiency in different size dispersity (50-500nm). Results showed that nanoparticles with dispersity in one magnitude were effective in increasing efficiency of electrode surface attachment, so as to improve the rate of combining cell-electrode repeatability. The relative AC impedance results also proved the deposition of platinum nanoparticles was beneficial for lower electrode body impedance and better surface activation treatment. Thus, Monte-Carlo quantitative assessment of surface treatment technology is useful to the establishment of high-throughput platform based on the experimental biology，computational biology and information processing by this combination of research methods.

Keywords: micro-electrodes array sensors (MEAS), cellular electrophysiology, Monte-Carlo model, nanoparticles, surface treatment of electrodes

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