Layer-by-layer assembly of biomolecule-silica nanoparticle hybrids for electrochemical biosensors

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Biomolecule-nanoparticle hybrid systems have excellent prospects for interfacing biological recognition events with electronic signal transduction so as to design a new generation of bioelectronic devices with high sensitivity. Direct electron transfer between redox proteins and electrodes is of practical and theoretical interest and can be improved by electrode or protein modification. Communication between proteins immobilized in multiple layers on the electrode can be achieved by in situ generation of small shuttle molecules or more advantageously by direct interprotein electron transfer. This allows the construction of new sensing electrodes.[1,2] As a new approach we have tested the use of modified silica nanoparticles (SiNPs) for the built up of fully electro-active cytochrome c (CytC) multilayer assemblies. For this purpose silica nanoparticles of different size are synthesized by adjustment of the Stöber method[3] and the SiNPs were modified by silan-based chemistry[4], to be applied for assembly formation by the layer-by-layer deposition technique.

In this study we use carboxy-modified SiNPs to provide an artificial environment - similar to that of the redox protein in the native system - to construct fully electro-active CytC multilayer architectures. The particles are characterized by dynamic-light-scattering (DLS), zeta-potential and FT-IR. The conditions of assembly formation and stability are determined by QCM. The electrochemical properties of the multilayer assemblies are analyzed by cyclic voltammetry (CV). Special focus is on the size influence of the SiNPs and the electron transfer ability of the multilayer assembly, in dependence on the deposited protein layers. This novel approach may provide a general way to fabricate enzyme multilayers useful in practical applications for biosensors. A future aim is the embedment of specific enzymes into these assemblies to obtain sensorial signal chains.

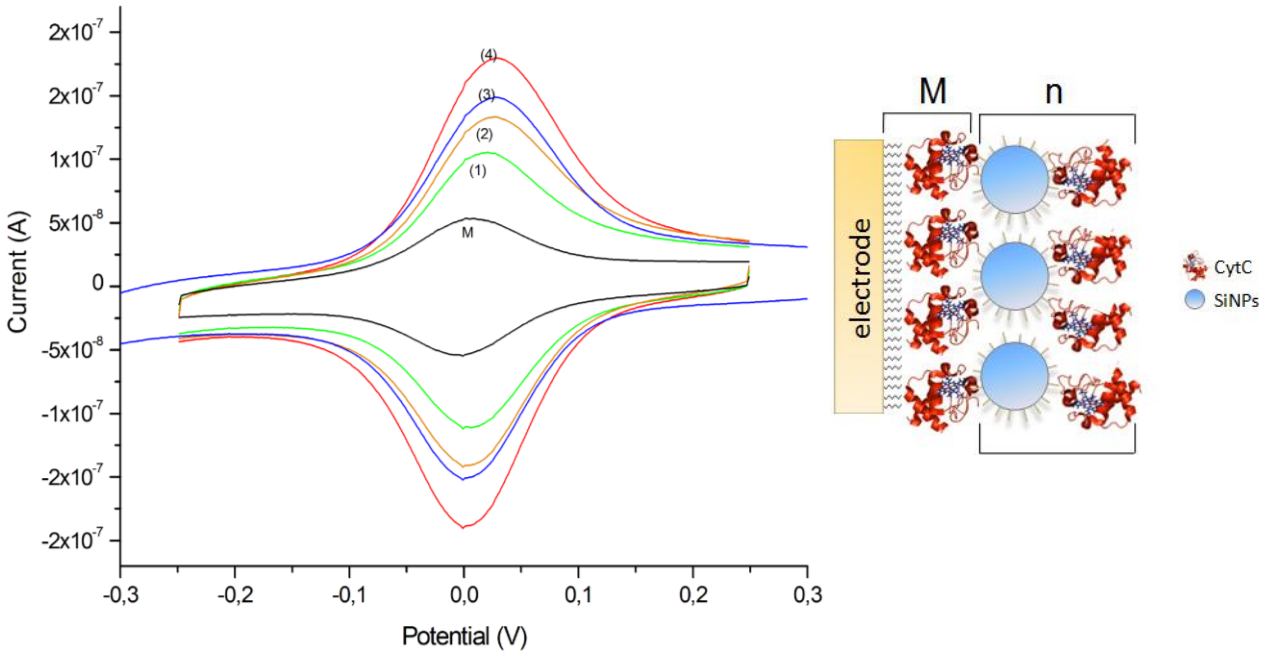

Figure 1. *Cyclic voltammetry of SiNPs/CytC multilayer assemblies, (M) Au-MU/MUA-CytC, (1) M-[SiNPs/CytC]$_1$, (2) M-[SiNPs/CytC]$_2$, (3) M-[SiNPs/CytC]$_3$, (4) M-[SiNPs/CytC]$_4$ for comparison (scan rate100 mV/s, KPP pH7).*

References

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