Boron-doped diamond modified with gold nanoparticles as analytical platform for the investigation of proteins

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Optically-transparent boron-doped diamond (BDD) electrodes (OTE) exhibit particularly attractive properties for the investigation of proteins, including high overpotential towards the oxygen reduction and hydrogen evolution reactions, spectroscopical transparency in the mid-infrared (mid-IR) region, high resistance to biofouling, and low background and noise current levels [1]. Besides, the modification of BDD surfaces with gold nanoparticles (AuNPs) not only improves the electrochemical response, but they can also interact with IR-active molecules, thereby promoting surface-enhance IR absorption (SEIRA) [2]. Although so far the SEIRA effect of BDD-AuNPs modified systems has not been intensively explored, the electrochemical and optical analysis of proteins using such modified OTEs may provide relevant information on their conformational changes and electrochemical interactions.

In the present contribution, BDD has been modified with AuNPs for the investigation of protein films of bovine serum albumin (BSA). First, the BDD electrode was amino-terminated by silanization with (3-aminopropyl)triethoxysilane (APTES). Then, the AuNPs were synthesized using a stainless steel-assisted method [3], and immobilized at the APTES-modified BDD surface. Both modification steps were in-situ monitored via IR-attenuated total reflection (IR-ATR) spectroscopy, and the resulting morphology was characterized via atomic force microscopy (AFM) using a combined AFM-IR-ATR setup [4]. SEIRA effect was clearly induced in the water absorption bands during the synthesis of the AuNPs [5], which could be correlated with the size, shape and density of the particles, as measured with the AFM. Films of globular and fibril BSA were next deposited on the resulting surface for their optical and electrochemical analysis. The AuNPs induced SERIA effect on the BSA, thereby facilitating the distinction between its globular or fibril conformation, which was obtained through the deconvolution of the IR response. In addition, increasing content of BSA progressively blocked the electrochemically-active sites of the gold particles, which was exploited for electroanalytical purposes. The proposed platform is regarded as particularly promising for the determination and investigation of proteins.

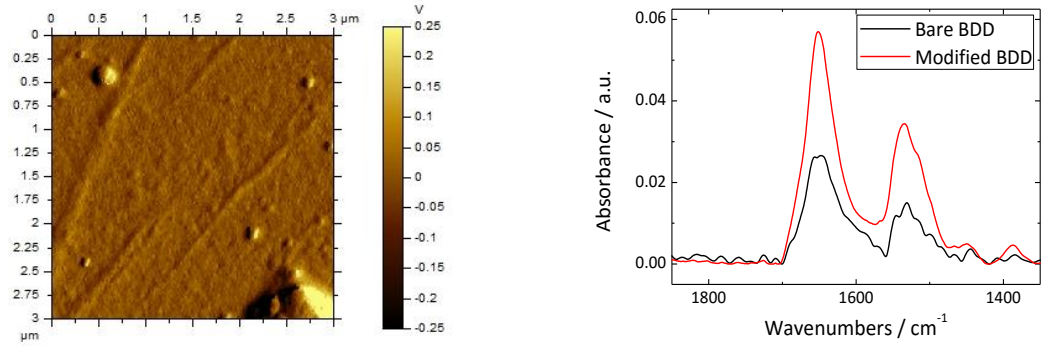

Figure 1 (left) AFM images of the BDD modified surface with further deposition of mixture of fibrils and globular BSA, and (right) IR-ATR response recorded for a film of proteins at the bare and modified BDD surface.

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