**Electron transport dependence of nanoscale hemeprotein molecular structures for engineering electrochemical nanosensor**

Fast and simple methods with high sensitivity and selectivity for H2O2 assessment are important in biological and medical fields. In this study, we explored the effect of nano-object hemeproteins (denoted as N-HP) with various bio-functionalities on the electrochemical sensing performance of working electrodes toward H2O2 molecules by affecting interfacial electron transport and surface properties of N-HP. We successfully constructed three enzyme-free H2O2 sensors by coating a three-dimensional open-pore nickel (3D-Ni) foam electrode with similar concentrations of three different N-HP namely, hemoglobin (Hb; 68.000 kDa, 7.0 nm), myoglobin (Mb, 16,950 kDa, 4.0 nm), and cytochrome c (Cyt.c, 12,327 kDa, 3.0 nm). The N-HP-modified Ni foam can be directly used as electrodes, thereby simplifying the electrode fabrication process and offering advantages, such as enhanced electrode-electrolyte contact area and minimum diffusion resistance. N-HP can function as redox mediators for shuttling electrons on the electrode-electrolyte interface and for engaging sufficient electro-active species exposed on the surface of the Ni foam for Faradaic redox reactions. The electrocatalytic activities of the Ni foam electrodes modified with different N-HP (i.e., Hb, Mb, and Cyt.c) in the selective oxidation of H2O2 were investigated. Among the N-HP-modified Ni foam electrodes, Cyt.c modified Ni foam electrode showed the highest sensitivity with reduced hysteresis between cathodic and anodic sweep and low detection limit (0.20μM, with signal to noise ratio of 3). This diversity in sensing performance originates from the versatility of the heme group with different bio-functionalities, different sizes and interactions at the surface of the immobilized Ni foam substrate. In addition, the N-HP-modified Ni foam electrodes exhibited no effects on major interferences, such as ascorbic, uric acids, dopamine, L-Cysteine (L. Cyst), vitamin A, L-glutathione. Hence, these electrodes can be applied in analyzing biological systems, such as lemon juice. Immobilization of different N-HP with different bio-functionalities and sizes onto Ni foam electrodes may facilitate the design and fabrication of novel biosensors.