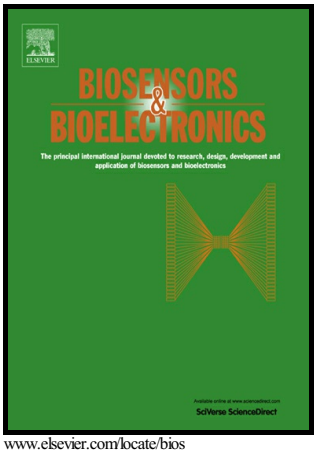

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Dawson-type polyoxometalate nanoclusters confined in a carbon nanotube matrix as efficient redox mediators for enzymatic glucose biofuel cell anodes and glucose biosensors

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Abstract: Two new inorganic-organic hybrid materials based on heteropolyoxometalates (POMs) : $(C_4H_{10}N)_6[P_2Mo_{18}O_{62}]$. $4H_2O$ (P_2Mo_{18}) and $(C_6H_8NO)_4[H_2P_2W_{18}O_{62}]$. $6H_2O$ (P_2W_{18}) are reported as mediators for electron transfer between FAD-dependent glucose dehydrogenase (FAD-GDH) and a multiwalled carbon nanotube (MWCNT) matrix for glucose biofuel cell and biosensor applications. These polyoxometalates were chosen due to their promising redox behavior in a potential range for mediated electron transfer with the glucose oxidizing enzyme, FAD-GDH. P_2Mo_{18} and P_2W_{18} were immobilized on 1-pyrenemethylamine (PMA) functionalized MWCNT deposits. After immobilization of FAD-GDH, the P_2W_{18}-modified MWCNT electrode demonstrated mediated electron transfer and provided a catalytic current density of 0.34 $mAcm^{-2}$ at 0.2 V vs SCE with an open circuit potential (OCP) of -0.08 V vs SCE. A 10-fold increase in catalytic current to 4.7 $mAcm^{-2}$ at 0.2 V vs SCE and a slightly lower OCP of -0.10 V vs SCE was observed for an equivalent electrode modified with P_2Mo_{18}.The apparent superiority of P_2Mo_{18} is related, at least in part, to its improved incorporation in the MWCNT matrix compared to P_2W_{18}. Both POM-modified bioanodes showed exceptional stabilities with 45% of their initial performances remaining after 15 days. The mediated electron transfer capacities of the POMs were also evaluated in a glucose sensor setup and showed very satisfying performances for glucose detection, including a sensitivity of 0.198 $mAmolL^{-1}cm^{-2}$, a satisfying linear range between 1 $mmolL^{-1}$ and 20 $mmolL^{-1}$, and good reproducibility for the P_2Mo_{18} electrode.

Keywords: Electron transfer mediator, Dawson type polyoxometalates, glucose biofuel cells, glucose dehydrogenase, multi walled carbon nanotubes