Electrochemical Application of Boron-doped Diamond Electrodes

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Boron-doped diamond (BDD) electrodes are very attractive material, because of their wide potential window, low background current, chemical inertness, and mechanical durability.[1] In these years, we have reported several examples for electrochemical sensor applications.[2] Here, novel microsensing systems for in vivo real time detection of local drug kinetics are reported. Furthermore, applications for electrochemical organic synthesis[3] including CO_2 reduction[4], and electrochemiluminescence (ECL) systems[5] are also reported.

Microsensing system for in vivo real time detection of local drug kinetics[2b]
We have developed a microsensing system for in vivo real time detection of local drug kinetics and its physiological relevance. The system consists of two different sensors of both a micro-sensor composed of BDD microelectrodes with tip diameter ~40 µm and a glass microelectrode. By using the system, we have first tested bumetanide, a diuretic that is ototoxic but applicable to epilepsy treatment.
CO_2 reduction[4]
We investigated the electrochemical reduction of CO2 to HCOOH in a flow cell using BDD electrodes. The faradaic efficiency (FE) for the production of HCOOH was as high as 94.7%. The selectivity for the production of HCOOH was more than 99%. Furthermore, recently, by optimizing certain parameters and conditions used in the electrochemical process with BDD electrodes, such as the electrolyte, the boron concentration of the BDD electrode, and the applied potential, we were able to control the selectivity and efficiency with which carbon monoxide is produced.[4c]
Electrochemiluminescence (ECL)[5]
A novel coreactant-free electrogenerated chemiluminescence (ECL) system is developed where $Ru(bpy)_3^{2+}$ emission is obtained on BDD electrodes. The method exploits the unique ability of BDD to operate at very high oxidation potential in aqueous solutions and to promote the conversion of inert SO_4^{2-} into the reactive coreactant $S_2O_8^{2-}$. This novel procedure is rather straightforward, not requiring any particular electrode geometry, and, since the coreactant is only generated in situ the interference with biological samples is minimized. The underlying mechanism is similar to that of the $Ru(bpy)_3^{2+}/S_2O_8^{2-}$ system. Furthermore, recently, another ECL system is presented. The system takes advantage of the unique properties of BDD to promote oxidation of carbonate (CO_3^{2-}) into peroxydicarbonate ($C_2O_6^{2-}$), which further reacts with water to form hydrogen peroxide (H_2O_2), which acts as a coreactant for $Ru(bpy)_3^{2+}$ ECL.

References

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