Highly Developed Boron-Doped Diamond/Glassy Carbon Anodes to Remediation of Diclofenac in Aqueous Environments

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Diclofenac (ethyl 2-[2-(2,6-dichlorophenyl)aminophenyl]), a commonly overdosed nonsteroidal anti-inflammatory drug (NSAID) that has analgesic, anti-inflammatory, and antipyretic properties. Diclofenac has become a persistent toxic substance in bodies of water, owing to its extraordinary resistance towards biodegradation. Diclofenac has been detected in surface waters in various countries e.g., United States, Austria and Germany, and the highest concentration detected was 4.4 μg/L [1].
Advanced oxidation processes with boron-doped diamond (BDD) anodes have demonstrated potential applications in the effective degradation of pharmaceutic substances, due to contaminants in water can be easily oxidized by a large quantity of hydroxyl radicals, which are produced from the electrolysis of water on the diamond surface. Moreover, using of BDD as a anode materials has various advantages, such as an inert surface, extremely wide potential window in aqueous solution, good repeatability and reproducibility, and corrosion stability [2].
Highly developed boron-doped diamond electrode was used for the electrolysis in galvanostatic condition of diclofenac in 0.1 M sodium sulfate, pH = 6.4. The growth of BDD on pretreated glassy carbon (GC) surface, manufactured using the microwave plasma-assisted chemical vapor deposition (CVD) process with different boron doping levels controlled by the [B]/[C] ratio in plasma. The influence of boron on the obtained material's structure by x-ray photoelectron spectroscopy and raman analyses, surface morphology using scanning electron microscopy, electrical properties and electrochemical parameters, such as - ΔE_p and k°, were investigated. Cyclic voltammetry performed in 0.1 M sodium sulfate with diclofenac in a three-electrode system shows the diclofenac oxidation peak. Higher diclofenac oxidation peaks indicate a larger electrochemical active electrode area (EASA) involved in the electro-oxidation reaction of diclofenac. The oxidation of diclofenac was promoted by hydroxyl radicals generated via the oxidation of water on the surface of highly developed BDD/GC. The degradation efficiency of diclofenac on the BDD/GC anode increased with an increasing current density and temperature. The oxidation rate and current efficiency of the diclofenac degradation obtained on the BDD/GC electrode, indicating that the galvanostatic electrolysis is a promising method for the treatment of pharmaceutical effluents.

References

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