Electrochemical treatment of effluents from electroplating shops using boron doped diamond electrodes

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Electroplating is a key technology for many industrial applications. Unfortunately, it is sometimes unavoidable to use environmentally harmful substances, such as cyanide, chromate, heavy metal ions and organic substances in these processes. In most cases, the disposal of these harmful substances requires special wastewater treatments.[1]

The organic substances (such as complexing agents, levelers, etc.) can be directly oxidised at the anode or indirectly using oxidising agents. The oxidising agents can be added to the solution, e.g. hydrogen peroxide (1.78 V vs NHE)[2] or chlorine (1.36 V vs NHE)[2], or they can be generated at the anode, such as OH-radicals "OH•" (2.8 V vs. NHE)[2] by the so-called electrochemical advanced oxidation process (EAOP). Due to the high redox potential, the OH• are able to oxidise almost any organic substance. In principle, the OH• formation compete with the oxygen evolution reaction. The amount of the anodically formed OH• depens on kinetic factors such as the interaction with the anode. For weak interactions between OH• and the anode the amount of OH• at the surface is higher and the oxidation potential of the electrode increases, while the overpotential for the oxygen evolution reaction also increases. The boron doped diamond (BDD) electrode is well known to have a high overpotential and therefore large amounts of OH• occurs at the surface.

In this contribution, it will present the latest results on the oxidation of organic compounds in electroplating wastewater with OH• generated by electrodes made of vapour deposited boron doped diamond (BDD) on niobium. Important parameters for the evaluation of the experimental data are the oxygen concentration, the current and voltage curves, the temperature, the chemical oxygen demand (COD) and the cyanide concentration. Furthermore, we will discuss the challenges we encountered when upscaling the process from the milli litre to the liter scale.

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References

[1] Mohamed T. Kamar et al., A critical review of state-of-the-art technologies for electroplating wastewater treatment, International Journal of Environmental Analytical Chemistry, 2020, DOI: 10.1080/03067319.2022.2098486

[2] Parsons S.A. and Williams M., Advanced Oxidation Processes for Water and Wastewater Treatment.: IWA Publishing, 2004, DOI: 10.2166/9781780403076