

# Electrochemical Technologies for Wastewater Treatment: Fundamentals, Current Advances and New Trends

Carlos Alberto Martínez-Huitle

Environmental and Applied Electrochemistry Laboratory, Institute of Chemistry, Federal University of Rio Grande do Norte, Lagoa Nova, CEP 59078-970, Natal-RN, Brazil

**Abstract:** Over the past decades, great progress has been made on the electrochemical technologies for the treatment of effluents containing organic pollutants. In fact, electrochemical technologies offer an alternative solution to many environmental problems in the process industry<sup>1-8</sup>. Among the destructive processes, the use of electrochemistry has been shown to be an excellent option in the treatment of highly complex matrixes containing toxic organic compounds. Among the main advantages of electrochemical processes, there are: (a) versatility (redox processes in diluted or concentrated solutions), (b) automatization (easy handling of electrical variables (current and potential) and control for data acquisition), (c) environmental compatibility (use of the electron as a reagent), (d) absence of muds, (e) high current efficient and (f) cost effectiveness. In this context, the present work gives an overview on the current status of the main electrochemical processes for wastewaters treatment. It summarizes the historical development of electrochemical processes for wastewater treatment and to discuss their fundamentals. In addition, recent advances on electrocatalysis for electrochemical treatment are examined by given examples. Practical applications (few examples) of electrochemical technologies in laboratory and industry and with the utilization of coupled processes are also described. Special emphasis is put on the properties of electrodes for the production of strong oxidizing species allowing the fast mineralization of organics and their use for water disinfection and decontamination. Recent advantages of the exposition of effluents to sunlight in the emerging photo-assisted procedures (solar photoelectrocatalysis and solar photoelectro-Fenton) are also presented. The use of electrochemical technologies as new alternative processes for producing high added value products is also introduced. Finally, the advantages and disadvantages of electrochemical technologies are also discussed, as well as the future prospective for these approaches.

- 1 C. A. Martínez-Huitle and M. Panizza, *Curr. Opin. Electrochem.*, 2018, **11**, 62–71.
- 2 M. Panizza and G. Cerisola, *Chem. Rev.*, 2009, **109**, 6541–6569.
- 3 E. Brillas, I. Sirés and M. A. Oturan, *Chem. Rev.*, 2009, **109**, 6570–6631.
- 4 I. Sirés, E. Brillas, M. A. Oturan, M. A. Rodrigo and M. Panizza, *Environ. Sci. Pollut. Res.*, 2014, **21**, 8336–8367.
- 5 C. A. Martínez-Huitle, M. A. Rodrigo, I. Sirés and O. Scialdone, *Chem. Rev.*, 2015, **115**, 13362–13407.
- 6 E. Brillas and C. A. Martínez-Huitle, *Appl. Catal. B Environ.*, 2015, **166–167**, 603–643.
- 7 S. O. Ganiyu, M. Zhou and C. A. Martínez-Huitle, *Appl. Catal. B Environ.*, 2018, **235**, 103–129.
- 8 C. A. Martínez-Huitle, M. A. Rodrigo and O. Scialdone, *Electrochemical water and wastewater treatment*, 2018, Elsevier, pp. 586.