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B. Electrochemical Engineering

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The aim of the electrochemical engineering group is the development of new industrial processes for treatment of waste and for recycling of chemicals. To achieve this goal, the research was oriented towards **three main directions**:

i) Development of new electrode material for the preparation of chemicals (in a clean process) and for treatment of waste.

ii) Development of new industrial electrochemical reactors with high-specific electrode surface area, low investment and operation costs.

iii) Optimization of electrochemical processes for the preparation of chemicals and for the treatment of waste.

The **most important results** obtained in our group during the last five years are summarized bellow:

- A generalized mechanism is proposed for the electrochemical selective oxidation or combustion of organics for synthesis and for wastewater treatment, respectively [1][2].
- For the scale-up of bipolar electrochemical reactors, a relation between the current by-pass (y) and two dimensionless numbers (G_b and B_n) were derived [3]

$$y = G_b (B_n + 1)$$

where G_b depends on the reactor geometry and B_n on the electrochemical parameters of the system.

- Development of dimensionally stable anodes (DSA) for the electrochemical transformation of 'non-biocompatible' (non-bio) organics to biocompatible (bio) organics before the biological treatment [4].

$$[\text{non-bio}] \xrightarrow[\text{treatment}]{\text{Electrochemical}} [\text{bio}] \xrightarrow[\text{treatment}]{\text{Biological}} CO_2 + \text{Biomass}$$

- Development of an industrial electrochemical process for the regeneration of oxidants [5].
- Electrochemical oxidation of organics and O_3 production using Solid Polymer Electrolytes [6].

In the last two years, the group was also interested in the electrochemical promotion of oxide catalyst for the treatment of volatile organic compounds (VOC). The obtained results have shown that the activity of IrO_2 catalyst films for the gas-phase combustion of ethylene (model pollutant) can be increased by up to a factor of 10 *via* anodic polarization of the IrO_2 catalyst relative to an Au electrode both deposited on Y_2O_3-stabilized ZrO_2 solid electrolyte [7].

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Christos Comninellis, of Greek origin, born in 1945, received his Bachelor of science in chemistry (distinction with honour) in 1970 from the University of Alexandria. From 1971 to 1975 he worked as a chemist at the Institute of chemical engineering at the EPFL where he achieved his Ph.D. in technical sciences in 1979. Appointed professor in 1996, he teaches electrochemical engineering, the treatment of industrial waste as well as chemical and biological technologies of the environment. His research work is concentrated on electrochemical processes for the recycling and the treatment of waste products. An applied research for the utilization of electrochemical techniques in induztry for the protection of the environment is a constant concern within his activities. As a result, the collaboration with the industry enabled the development of oxidation processes with regeneration of the oxidant using a new type of bipolar electrochemical reactor. Prof. *Comninellis* has published over 80 scientific papers, directed 10 doctoral theses and has been an invited speaker at over 20 technical symposia.

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