Fundamentals, innovations, and future challenges of electrochemical technology for the abatement of organics in the water-energy Nexus sectors

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Nexus concept is the interconnection between the resource's energy, water, food, land and climate. Interconnections between the Nexus sectors may benefit from climate change, energy demand, among others, to sustainable development goals (SDGs) through the integrated planning and management processes. 17 SDGs were established in several subject areas, such as water, energy, climate, oceans, urbanization, transport, science, and technology, to achieve it. Materials science has considerably contributed to the accomplishment of several SDGs, according to report maps of the most current sustainability initiatives and research within each SDG area. Advanced materials, for instance, may aid in achieving development objectives in key areas of focus on, for example, clean water and sanitation (SDG 6), affordable and clean energy (SDG 7), industry, innovation and infrastructure (SDG 9), sustainable cities and communities (SDG 11), responsible consumption and production (SDG 12). Then, the scientific and technological domains may develop and construct practical solutions in materials and their applications by identifying essential insights to open novel branches and landscapes for maximizing social benefits. Within this framework, innovative approaches to catalyst creation and electrode production are explored by electrochemistry, electrochemical engineering and material sciences in themes that aim to increase environmental sustainability and Nexus interconnections. Electrochemical driven processes have emerged as efficient and sustainable technologies for the detection and removal of pollutants in water matrices, production of fuels, green organic synthesis, wastes valorization, reduction of CO_2. In this frame, electrochemistry is playing a key role in environmental protection, resources recovery, and climate neutrality, which could be simultaneously achieved when a Nexus applicability is visioned. This challenge is related to the lower production of wastes because of the direct use of electron as reagent, the improvements on the electrochemical transformations and, most importantly, because electrochemical processes can be powered with green energies or generate energy sources, contributing to a reduction in the carbon footprint of processes. Then, the integration of electrochemical approaches with materials science towards the future of Nexus-electrocatalytic technologies will be presented.

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