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Editorial: New applications of advanced materials in water and wastewater treatment and energy systems

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Editorial on the Research Topic
New applications of advanced materials in water and wastewater treatment and energy systems

Water is a necessary resource for human life and to carry out an endless number of daily activities ranging from domestic to industrial. Drinking water is withdrawn from water bodies, such as surface water or groundwater, and passes through treatment systems before being distributed to households (Taheran et al., 2019). After being used, the water is transported through a sewage system to be collected and treated in treatment plants, to finally be discharged into surface waters (Eriksson et al., 2002; Fu et al., 2022). For its part, energy, like water, is a fundamental resource to face the great challenges and opportunities facing the world today (Saavedra et al., 2021). The demand for water and energy has increased due to population growth and the development of cities, so the society-economy binomial depends on both available energy and available clean water (Bhat et al., 2021). Good management of both resources contributes to the sustainability of the environment.

For the treatment of water and wastewater, different processes or unit operations are used depending on the content of pollutants. These processes can be of the conventional type or processes currently under development, such as those in which advanced materials are used for the removal of specific contaminants such as emerging ones. Advanced materials can be used for adsorption, filtering, etc. In the case of energy, new technologies are evaluated that are also based on advanced materials (Saavedra et al., 2021). Advanced materials can be described as systems designed with specific materials that vary in their nature, characteristics, shape, and dimensions. In recent years, the invention of advanced materials has become an area of significant scientific and technological interest, due to its applications in the design and manufacture of innovative products in various fields (Santhosh et al., 2016). One of these is new technologies applied in water and energy systems. Specific examples include solar cells, water filters, materials used for pollutant adsorption, and photocatalysis, among others. These new technologies are necessary due to the increasing demand for energy and the decrease in the availability and quality of water. The problems of scarcity and high

consumption of water, coupled with the growing effects of climate change due to the excessive use of fossil fuels, make it necessary to seek innovative alternatives to remedy such problems (Santhosh et al., 2016; Bhat et al., 2021).

This Research Topic Research Topic covers the synthesis and characterization of catalytic and photocatalytic materials for the removal of emerging contaminants and pathogens in water. Alternatives are evaluated to improve carbon-based materials for electrochemical systems and treat industrial wastewater. Finally, the nature and grouping of energy resources are analyzed. This Research Topic of papers is formed of four original research articles, one brief research report article, and one opinion article. A description of each is given below.

Aguilar et al. study the degradation of acetaminophen (ACET) with TiO2-Ag catalysts, whose predominant crystalline phase was anatase, synthesized by the sol–gel method and doped by photo-deposition under UV radiation with silver particles. The silver deposited as metallic particles on the catalyst by photodeposition promotes changes in the surface of the semiconductor that make it active in visible light; the amount of 1.17% by weight of metallic silver deposited is sufficient to consider a material capable of removing more than 80% of the initial concentration of acetaminophen under the action of visible light. Martins et al. also show the use of silver nanoparticles but in PAN-based activated carbon fibers (ACF). They evaluate the potential application of activated carbon felt produced from PAN and decorated with silver nanoparticles for water treatment, by assessing the microbial retention efficiency and toxicity of the filtered water. They found that the silver nanoparticles were successfully incorporated into textile carbon fibers using a cheap and electro-less method of production and the textile PAN is five times less expensive than special acrylic fiber and for this reason, it could be a cheaper option. In addition, the microbial suspensions filtered for 24 h through textile carbon fibers decorated with nanoparticles of Ag (Ag@ACF) showed time-dependent reduction for *E. coli* and *C. albicans*, with reductions of 97.8% and 100%, respectively.

From the perspective of environmental sustainability, it is essential to consider using renewable raw materials or materials that exert a low impact on the environment, making it a significant priority to manufacture new applications of advanced materials in treatment techniques. In accordance with this, the authors, He et al., investigate the use of cow dung as a raw material for biochar to prepare the catalyst CMB@1T-MoS2 for advanced oxidation processes by high-temperature calcination and hydrothermal technique. They found that the calcination and hydrothermal method exhibited good catalytic performance for peroxymonosulfate (PMS) and effectively degraded Dimethyl phthalate (DMP) in an aqueous environment. Under alkaline conditions, the activation of PMS by Mo4+ was inhibited due to the dissociation of S efficiency being reduced, thus affecting the degradation of emerging contaminants.

Estrada et al. carry out another interesting investigation. They study the effect of calcination at 300°C and 600°C of carbon clothes in the oxidation current and H_2O_2 production at different potentials in H_2SO_4. Most of the works regarding the H_2O_2 electro-generation involve relatively complex processes to enhance the catalytic activity or the electrochemically active area of these electrodes. In this investigation, they show that the calcination by itself represents a simple and low-cost option to enhance cathodic and anodic functions, especially in the fabrication of large area electrodes that could be needed to treat a large amount of difficult industrial wastewater such as tequila vinasses that are produced daily. Ahmadi et al. evaluate the efficient wastewater treatment via aeration through a novel nanobubble system in sequence batch reactors. They found that the aerobic wastewater treatments seriously depend on the aeration, hence, the size of the bubbles used in the aeration system plays a significant role, according to it result. Because many parameters were influenced by the nanobubbles, for example increasing the solids retention times, reducing chemical oxygen demand, and increasing the production rate of concentration of suspended solids in biomass.

Finally, in this Research Topic, Ramkumar and Marimuthu describe work related to energy systems. They show that new sources and methods are explored to be regrouped energy sources necessarily based on their characteristics. This opinion proposes four criteria for classifying energy in a particular classification: carbon neutrality, eco-friendly, nature of availability, and usage at present. The choice of these four criteria is considered because of their crucial role in making energy sources sustainable.

In conclusion, this Research Topic provides an overview of recent advances in advanced materials with the potential for the removal of emerging pollutants and treatment of industrial wastewater (vinasse) and of the use of biological feedstock to generate carbon materials. In addition, the improvements in water treatment systems using nanotechnology and in the analysis of energy systems are shown.

Author contributions

All authors listed have made a substantial, direct, and intellectual contribution to the work and approved it for publication.

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Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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