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Materials and Clean Processes for Sustainable Energy and Environmental Applications

Materials and clean processes for sustainable energy and environmental applications: Foreword

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Abstract. Sustainable development strives to fulfill present human needs while safeguarding the ability of future generations to meet their own requirements. Climate change is frequently identified as a major obstacle to realizing this goal. Our current dependence on fossil fuels for energy production is the primary contributor to global climate change. The pivotal solution lies in transitioning to sustainable energy generation by using natural resources like the sun, water, wind, biomass, and others. This shift is fundamental to mitigating climate change and preserving the environment. Utilizing these sources instead of fossil fuels markedly diminishes greenhouse gas emissions, helps in the establishment of a carbon-free global economy. This special edition in Comptes Rendus Chimie (CRC) delves into recent research exploring the role of natural materials, particularly waste, in the production of sustainable energy and environmental protection against both gaseous and liquid pollutants.

Keywords. Sustainable energy, Environmental protection, Waste.

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1. Introduction

Nowadays, global economic expansion heavily relies on the energy sector. Most of the consumed energy is still derived from fossil fuels combustion. This practice has detrimental effects on both human health and environmental ecosystems. Local air pollution and global warming are usually linked to the emission of various greenhouse gases (GHGs) from non-renewable energy systems. Addressing these adverse impacts underscores the urgent need for the global development of innovative and sustainable strategies in renewable energy production and storage. Consequently, the transition to sustainable energy was considered a focal point in both the Paris Agreement on climate change and the United Nations Sustainable Development Goals (SDGs). For instance, The SDG7 main objective is "Ensure access to affordable, reliable, sustainable and modern energy for all".

Sustainable energy is derived from renewable and diverse sources, with minimal to no generation of GHGs or other pollutants. Embracing this shift in energy production holds the potential to address various challenges, including ensuring energy supply security, preserving the environment, promoting social well-being, and fostering economic development. A significant focus has been placed on developing eco-friendly, clean, cost-effective, and scalable tech-

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nologies not only for energy production but also for its storage. The use of materials plays a crucial role in advancing the transition to sustainable energy, making it a promising research avenue for the upcoming decades. In this context, the valorization of abundant and recyclable materials holds a particular interest, offering innovative and cost-effective solutions for both energy recovery and environmental protection against pollution.

Recent studies emphasize a significant interest in utilizing organic materials, such as biomasses, as promising alternatives to fossil fuels. Simultaneously, these materials offer a sustainable approach to managing large solid wastes effectively. These materials can serve as low-cost sources for renewable energy recovery. Various thermochemical technologies are being explored for this purpose, including gasification, hydrothermal carbonization, pyrolysis, etc. Some of these technologies, such as pyrolysis, generate solid residues that can add substantial values to different sectors, including agriculture and the environment. For instance, these residues can be employed as slow-release fertilizers, replacing synthetic and commercial fertilizers and thereby significantly reducing associated GHGs emissions. Additionally, when applied as soil amendments in agriculture, these materials exhibit a remarkable ability to sequester carbon and nitrogen emissions and to supply the plants with the required minerals for their development. Moreover, these raw or modified materials can efficiently contribute to treating liquid and gaseous effluents, offering an alternative to expensive materials like activated carbons and other environmentally detrimental technologies.

The current special issue in the journal "Comptes Rendus Chimie" is entitled: "Materials and clean processes for sustainable energy and environmental applications". It is intended to provide an update on the most recent research activities regarding the use of natural/advanced materials as well as eco-friendly industrial processes for the promotion of sustainable energy production and also environment protection.

2. Outcomes

This special issue comprises 14 papers that have undergone peer review process. The papers delve into various subjects, including: (i) the utilization of cost-effective materials for sustainable energy production, (ii) the application of both raw and modified materials in treating effluents for subsequent use within the framework of a circular economy, and (iii) the significance of generating sustainable energy in mitigating climate change and safeguarding the environment.

The first part of this special issue focuses on the optimization of experimental conditions for the production of renewable energy from various materials [1–5]. For example, Yerizam et al. [1] report that increasing the use of deep eutectic solvents and natural deep eutectic solvents enhances the delignification efficiency and consequently leads to increased bioethanol production from coconut husk wastes. Additionally, Kerras et al. [2] demonstrate that pretreating waste cooking oil with ultrasounds or microwave irradiations significantly reduces its acidity, resulting in higher biodiesel production yields (96–98%). Moreover, based on a study in a rural Pakistani area, Junejo et al. [3] confirm that the use of natural draft improved cook stoves reduces fuel wood consumption as well as the emissions of carbon monoxide, carbon dioxide, and particulate matter. Similarly, the thermochemical conversion of a local Moroccan wood "Ficus nitida" through pyrolysis under various experimental conditions was investigated [4]. The results indicate that the produced biochars exhibit a high calorific value and a high percentage of carbon. However, the bio-oil produced requires an upgrading step due to the presence of high contents of aliphatic, phenolic ketones, and aromatic groups. Likewise, enhanced physicochemical and energetic properties of biochars can be achieved by blending orange peels with various agro-food wastes, and especially peanut shells and coffee grounds [5].

The current special issue also explores the extraction of specific materials from waste or by-products, as well as the modification of these materials for purposes related to energy, the environment, and diet [6–9]. Within this context, an innovative method was tested to effectively separate PVC from PET fibers in PVC-coated fabric waste [6]. Additionally, safeguarding mild steel against bio-corrosion was achieved by coating it with polyetherimide-ZnO or CuO bilayer composites [7]. Furthermore, a study emphasized the significance of heat, as well as a combination of heat and ultrafiltration operations, in influencing the

bacterial activity of a model protein (lysozyme) [8]. Lastly, the successful production of a dietary supplement from spirulina and date stones was demonstrated [9]. These tablets were proven to be a rich source of essential nutrients and various active ingredients such as phenolic compounds and phycocyanin.

This special issue also includes relevant papers addressing the utilization of specific materials derived from wastes for environmental and agricultural purposes [10–13]. Within this context, Hosni et al. [10] demonstrate that calcined double-layered hydroxides can exhibit noteworthy treatment efficiency for olive mill wastewater. Furthermore, Nouira et al. [11] reveal that activated carbons generated from water bottle wastes effectively remove herbicides from synthetic aqueous effluents. Moreover, these materials possess properties comparable to sub-bituminous and bituminous products. Additionally, biochars produced from olive mill solid and liquid wastes were found to positively influence agricultural soil and plant growth characteristics [12]. Lastly, the use of titanium-based metal oxide anodes is found to be highly effective for bacteria electrooxidation [13].

In a final contribution, Papamichael et al. [14] illustrate that the current system employed for environmental impact assessment studies in Greece could be significantly enhanced through improved cooperation between organizations responsible for environmental affairs, environmental education, and social training.

Declaration of interests

The authors do not work for, advise, own shares in, or receive funds from any organization that could benefit from this article, and have declared no affiliations other than their research organizations.

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