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Editorial

New Trends in the Use of Catalysts for Biofuel and Bioproduct Generation

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1. Introduction

Green technologies are gaining a vital role in the energy and industrial fields, as society faces challenges such as geopolitical conflicts and pollution related to the exploitation of petroleum resources [1–3]. These sustainable processes should be efficient, ensuring real competition with traditional refineries. The contribution of catalysts for this purpose is crucial, along with the following requirements:

- They should be low-cost.
- Their use should not be detrimental to industrial facilities (especially avoiding corrosion).
- Their life cycle assessment should be positive, with low environmental impact in their production and performance.
- The effectiveness, efficiency, and selectivity of these catalysts should be as high as possible.

As expected, traditional catalysts often do not comply with some of these requirements, and the use of different additives or alternatives for their production is an important research trajectory.

In this regard, there is a wide range of research (for different processes) focused on the improvement of the abovementioned characteristics, presenting innovative alternatives in the following areas [4–6]:

- The use of new raw materials that are sustainable, with the aim of reducing the environmental impact of catalyst production, as well as their subsequent post-treatment.
- The improvement in the durability or reusability of these catalysts, improving their efficiency and positive environmental impact during catalytic performance.
- Better selectivity to produce the desired products rather than undesired products (which are usually environmentally harmful).
- The development of catalysts for new chemical routes to valorize some wastes obtained in traditional processes, making their management easier and useful.
- The contribution of these catalysts to the implementation of sustainable processes in developing areas, enhancing the sustainable growth of these regions.

Thus, the abovementioned challenges, requirements, and topics are addressed in the works included in this Special Issue.

2. An Overview of the Published Articles

Considering the above, the aim of this Special Issue is to cover new trends in the use of catalysts for biofuel and bioproduct generation focused on different aspects such as their characterization, efficiency, or possible use at industrial scale. These issues are examined in different research and review works carried out by prestigious scientific researchers from across the globe (Australia, China, Israel, Malaysia, Pakistan, Spain, Taiwan, Thailand, the

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United Kingdom, and the United States), focused on different applications such as biofuel production (as in the case of biodiesel from different sources) or thermochemical and biological lignocellulosic conversion (for instance, steam gasification). The main subjects of this Special Issue are detailed in Figure 1.

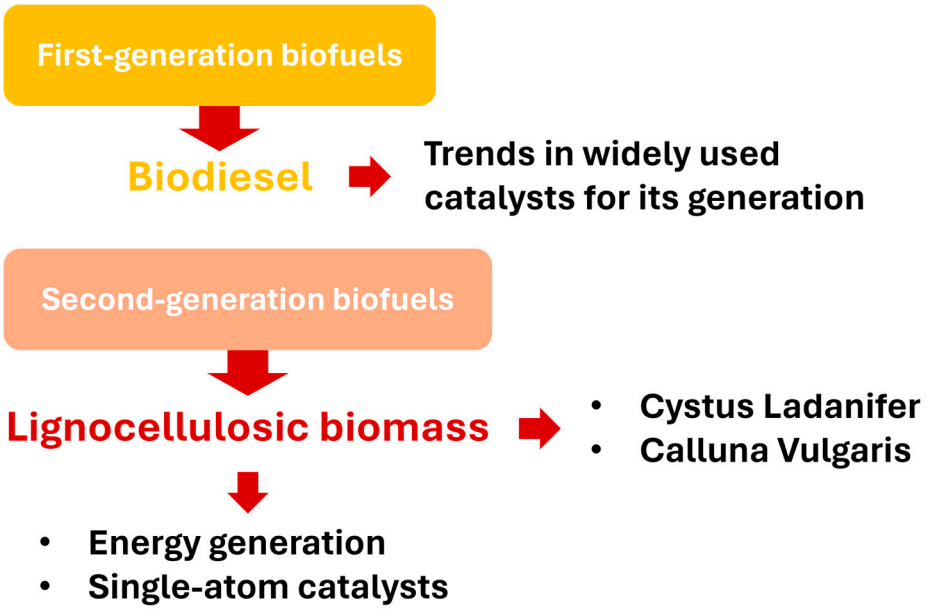

Figure 1. Main subjects included in this Special Issue.

Several works include review studies about first- and second-generation biofuels, along with examples that fit the subjects included in these reviews.

Concerning first-generation biofuels, the work carried out by Nisar et al. assessed the use of homogeneous and heterogeneous catalysts for fatty acid methyl ester (FAME) production, showing some of the most innovative catalysts used in this field, such as heteropoly acid, polyoxometalate compounds, or carbonaceous materials, which can be easily separated once FAMEs are produced. Some examples of specific FAME production are included in this Special Issue, including the adaptation of these processes to obtain biodiesel from brown grease, as explained by Kolet et al., where homogeneous and heterogeneous acid catalysts with ultrasonic activation were used, obtaining high yields in short reaction times. Another example is the work presented by Hassan and Smith, where the non-catalyzed supercritical alcohol process for continuous biodiesel production was studied, with high yields (exceeding 90%) that avoided the addition of homogeneous catalysts, whose separation and management could be difficult.

Regarding second-generation biofuels, Haq et al. considered the different routes to produce bioenergy from lignocellulosic biomass taking into account its composition for the adaptation of different processes, with the use of cost-effective technology and, therefore, catalysts. In that sense, as explained by Gomez-Bolivar et al., with an interesting example of biohydrogen production from cellulose, its hydrothermal liquefaction presented a negative energy balance, requiring advances in the catalytic upgrading of some stream products like 5-hydroxymethyl furfural. Thus, the role of photo-fermentation of organic acids could contribute to generate 4.05 mol of H_2 per mole of organic acid. Other work carried out by Encinar et al., including the valorization of lignocellulosic biomass like *Calluna vulgaris* or *Cistus ladanifer* biochar through catalytic steam gasification, presents kinetic studies that could be useful for the implementation of this technology at an industrial scale. Finally, Asikin-Mijan et al. offered a review of single-atom catalysts, focused on the stabilization of these products to operate efficiently and with high durability during the corresponding process.

To summarize, these works detail a wide range of possibilities for the valorization of biomass to obtain different value-added products through the use of catalysts of a different nature, specifically adapted to the circumstances of each process, especially depending on the characteristics of the different raw materials.

3. Conclusions

Throughout the various research works included in this Special Issue, a series of conclusions can be drawn, as follows:

- The use of new catalysts could allow the use of different raw materials to directly produce energy or other value-added products, with high efficiency compared to traditional processes based on petrol.
- The development of new and effective heterogeneous catalysts (instead of traditional catalysts such as homogeneous ones) is essential to carry out green processes, where the separation step of these catalysts is simpler, especially when it comes to FAME production.
- Considering the above, supercritical conditions could be an interesting starting point for FAME synthesis and the subsequent avoidance of homogeneous catalysts.
- The stability or durability of the catalysts used for first and second-generation biofuel production is essential in these processes, where the development of innovative improvements seems to be one of the most trending research areas.

Conflicts of Interest: The authors declare no conflicts of interest.

List of Contributions:

1. **Contribution 1**: Nisar, S.; Hanif, M.A.; Rashid, U.; Hanif, A.; Akhtar, M.N.; Ngamcharussrivichai, C. Trends in Widely Used Catalysts for Fatty Acid Methyl Esters (FAME) Production: A Review. *Catalysts* **2021**, *11*, 1085. https://doi.org/10.3390/catal11091085
2. **Contribution 2**: Kolet, M.; Zerbib, D.; Nakonechny, F.; Nisnevitch, M. Production of Biodiesel from Brown Grease. *Catalysts* **2020**, *10*, 1189. https://doi.org/10.3390/catal10101189
3. **Contribution 3**: Hassan, A.A.; Smith, J.D. Laboratory-Scale Research of Non-Catalyzed Supercritical Alcohol Process for Continuous Biodiesel Production. *Catalysts* **2021**, *11*, 435. https://doi.org/10.3390/catal11040435
4. **Contribution 4**: Haq, I.u.; Qaisar, K.; Nawaz, A.; Akram, F.; Mukhtar, H.; Zohu, X.; Xu, Y.; Mumtaz, M.W.; Rashid, U.; Ghani, W.A.W.A.K.; et al. Advances in Valorization of Lignocellulosic Biomass towards Energy Generation. *Catalysts* **2021**, *11*, 309. https://doi.org/10.3390/catal11030309
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