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2021 Pioneers in Energy Research: Javier Bilbao

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Energy & Fuels has established annual Pioneers in Energy Research (PIERs) for honoring highly influential scientists who have made pioneering contributions to respective fields of energy research.[1] Professor Javier Bilbao (University of Basque Country, Spain) has been selected as the first PIER in the field of bioenergy, biofuels, and biorefinery for his outstanding contribution to the area of biomass and waste conversion.

Professor Javier Bilbao obtained his degree in chemical sciences (industrial chemistry branch) in 1973 and Ph.D. degree in 1977, both at the University of the Basque Country (UPV/EHU, at that time called University of Bilbao). He has conducted teaching and research activities in the Department of Chemical Engineering at this university, where he has been the leader of the team Catalytic Processes & Waste Valorization (CPWV) since 1980. At the beginning of his career, he specialized in the kinetic modeling and design of chemical processes on acid catalysts [zeolites and silicoaluminophosphates (SAPOs)] for the conversion of methanol and ethanol into hydrocarbons and catalytic cracking in fluid catalytic cracking (FCC) units. His contributions in these topics cover the characterization of deactivated catalysts, coke analysis, kinetic modeling of the deactivation and regeneration, and reactor design. Professor Bilbao then adapted the research activities within the platforms of biorefinery and waste refinery. His work on the catalytic conversion of biomass and wastes to produce fuels, chemicals, and H_2 has attracted a broad international impact. He has been involved in the management and assessment of research and development (R&D) activities in Spain's ministries and the leader of around 75 projects and participated in more than 150 projects, financed by Spanish and European entities as well as companies (Total Petrochemical, Eastman, Johnson Matthey, etc.). These activities have led to ∼500 research articles, 8 patents, and 40 supervised Ph.D. students. He has been awarded the national prize in chemical engineering by the Spanish Royal Society of Chemistry (2006) and the research excellence prize by the National Association of Chemists and Spanish Chemical Industry (2019).

Professor Bilbao has made pioneering contributions to the development of new thermal and catalytic processes within the platforms of biorefinery and waste refinery, particularly thermocatalytic processes (pyrolysis and gasification) for the direct production of H_2 and raw materials from biomass and residues. These original and pioneering contributions include (1) the development of technologies based on the conical spouted bed[2] and spouted bed−fluidized bed tandem reactors,[3−5] (2) catalytic reforming for the production of H_2 from biomass-derived oxygenates (bio-oil, ethanol, and dimethyl ether), with highly relevant results being obtained in the valorization of raw bio-oil,[6−12] (3) synthesis of dimethyl ether, fuels, and raw materials from syngas and CO_2, with original core−shell catalysts[13] and hydrophilic membranes,[14] (4) cracking and hydrocracking of bio-oil and side streams in refineries and those from consumer society wastes (plastics and tires),[15−18] with the original aspect being the use of refinery conditions,[19−21] (5) methodologies for the study and control of the deactivation[22] and regeneration[23] of new sustainable catalysts, which have being approached in all of the processes studied, (6) new sustainable catalytic processes for the production of olefins and aromatics[24] from paraffins, biomass-derived oxygenates, and methane (via chloromethane), with the proposal of dimethyl ether to olefins (DTO),[25] and (7) hydrodynamic modeling and pilot plant implementation of reactors and equipment for physical operations (separation, drying, and granulation) and chemical processing involving biomass and other solids,[26] with the use of spouted beds and micro- and nanocyclones being specifically remarkable.

To celebrate the achievement of Professor Bilbao as one of the 2021 PIERs, *Energy & Fuels* is also pleased to present this special issue consisting of research articles contributed by invited authors. In conclusion of the usual rigorous peer-review process of the journal, a total of 16 papers (including 7 reviews) have been accepted for publication in this special issue, as listed in Table 1. These research articles describe some of the latest fundamental research and technology development in various topics in the field of bioenergy, biofuels, and biorefinery. A concise synopsis of each article is given below.

PYROLYSIS OIL

Peterson et al.[27] have investigated the global oxidation rates of prominent products (levoglucosan, xylose, and acetic acid) of fast pyrolysis of lignocellulosic biomass at temperatures appropriate to autothermal pyrolysis. These results are useful in efforts to develop reaction models of autothermal pyrolyzers. Pujro et al.[28] have reviewed the various catalytic reactions involved during pyrolysis oil upgrading, with a special emphasis on the transfer of hydrogen, for deoxygenation, which can be potentially donated "*in situ*" by the molecules (such as

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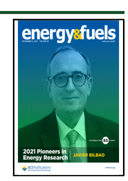

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Table 1. List of Articles Published in the "2021 Pioneers in Energy Research: Javier Bilbao" Special Issue

topic	first and corresponding author	institution of the corresponding author	title (DOI)	article type
pyrolysis oil	Peterson and Brown[27]	Iowa State University, Ames, IA, U.S.A.	Global Gas-Phase Oxidation Rates of Select Products from the Fast Pyrolysis of Lignocellulose (10.1021/acs.energyfuels.1c01207)	original article
pyrolysis oil	Pujro and Sedran[28]	Instituto de Investigaciones en Catálisis y Petroquímica (INCAPE), Santa Fe, Argentina	Review on Reaction Pathways in the Catalytic Upgrading of Biomass Pyrolysis Liquids (10.1021/acs.energyfuels.1c01931)	review
pyrolysis oil	Fonts and Bilbao[29]	University of Zaragoza, Zaragoza, Spain	Thermodynamic and Physical Properties Estimation of Compounds Derived from the Fast Pyrolysis of Lignocellulosic Materials (10.1021/acs.energyfuels.1c01709)	original article
pyrolysis oil	Cordero-Lanzac[30]	University of Málaga, Málaga, Spain	Advances and Challenges in the Valorization of Bio-Oil: Hydrodeoxygenation Using Carbon-Supported Catalysts (10.1021/acs.energyfuels.1c01700)	review
biorefinery	Kannah and Kumar[31]	Yonsei University, Seoul, Republic of Korea	A Mini Review on Biochemical Conversion of Algal Biorefinery (doi/10.1021/acs.energyfuels.1c02294)	review
biorefinery	Ipiales and Rodriguez[32]	Universidad Autónoma de Madrid, Madrid, Spain	Integration of Hydrothermal Carbonization and Anaerobic Digestion for Energy Recovery of Biomass Waste: An Overview (10.1021/acs.energyfuels.1c01681)	review
biorefinery	Zhang and Wang[33]	Zhejiang University, Hangzhou, China	Selective Demethoxylation of Lignin-Derived Methoxyphenols to Phenols over Lignin-Derived-Biochar-Supported Mo_2C Catalysts (10.1021/acs.energyfuels.1c01894)	original article
biorefinery	Afailal and Arauzo[34]	University of Zaragoza, Zaragoza, Spain	Antioxidant Additives Produced from Argan Shell Lignin Depolymerization (10.1021/acs.energyfuels.1c01705)	original article
biorefinery	Kumar and Thallada[35]	Council of Scientific and Industrial Research (CSIR)−Indian Institute of Petroleum (IIP), Dehradun, India	Lignin Biorefinery: New Horizons in Catalytic Hydrodeoxygenation for Production of Chemicals (10.1021/acs.energyfuels.1c01651)	review
biorefinery	Arroyo and Serrano[36]	IMDEA Energy Institute, Madrid, Spain	Selective Decarboxylation of Fatty Acids Catalyzed by Pd-Supported Hierarchical ZSM-5 Zeolite (10.1021/acs.energyfuels.1c01373)	original article
H_2 from biomass and wastes	Condori and Adanez[37]	Instituto de Carboquímica, Zaragoza, Spain	Syngas Production in a 1.5 kW_{th} Biomass Chemical Looping Gasification Unit Using Fe and Mn Ores as the Oxygen Carrier (10.1021/acs.energyfuels.1c01878)	original article
H_2 from biomass and wastes	Santamaria and Olazar	University of the Basque Country, Bilbao, Spain	Progress on Catalyst Development for the Steam Reforming of Biomass and Waste Plastics Pyrolysis Volatiles. A Review (10.1021/acs.energyfuels.1c01666)	review
H_2 from biomass and wastes	Valecillos and Gayubo	University of the Basque Country, Bilbao, Spain	Insights into the Reaction Routes for H_2 Formation in the Ethanol Steam Reforming on a Catalyst Derived from $NiAl_2O_4$ Spinel (10.1021/acs.energyfuels.1c01670)	original article
CO_2 and other topics	Solomon Embaye and Malankowska and Coronas[38]	University of Zaragoza, Zaragoza, Spain	Poly(ether-*block*-amide) Copolymer Membranes on the CO_2 Separation Applications (10.1021/acs.energyfuels.1c01638)	review
CO_2 and other topics	Tarifa and Monzon[39]	University of Zaragoza, Zaragoza, Spain	Highly Active Ce- and Mg-Promoted Ni Catalysts Supported on Cellulose-Derived Carbon for Low-Temperature CO_2 Methanation (10.1021/acs.energyfuels.1c01682)	original article
CO_2 and other topics	Torres-Linan and Cordero[40]	University of Málaga, Málaga, Spain	Deactivation of Biomass-Derived Zirconium-Doped Phosphorus-Containing Carbon Catalyst in the Production of Dimethyl Ether from Methanol Dehydration (10.1021/acs.energyfuels.1c01721)	original article

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alcohols) present in the bio-oils. Fonts et al.[29] have proposed a simple but representative composition of a biomass pyrolysis oil, which can be used as a bio-oil surrogate. Then, they have determined selected thermodynamic, physical, and molecular properties of the organic compounds included in the bio-oil surrogate. Cordero-Lanzac et al.[30] have reviewed the potential interest and the mechanisms of pyrolysis oil upgrading over carbon-supported catalysts. These catalysts can be produced by the pyrolysis of biomass wastes.

■ BIOREFINERY

Kannah et al.[31] have reviewed the pretreatment of algae followed by the different biochemical processes of algae conversion into hydrogen, methane, ethanol, or plastics. The environmental and technical−economical aspects of integrated algae biorefinery are also discussed. Ipiales et al.[32] have published a comprehensive coupling of hydrothermal conversion of wastes with the anaerobic digestion of process water, with a special emphasis on the nutrients to produce fertilizers. Energy balances and economical and environmental assessment are also included in this review. Zhang et al.[33] have proposed to use the biochar from lignin as a catalyst support of Mo_2C for hydrodeoxygenation (HDO) of lignin-derived methoxyphenols. Different methoxyphenol surrogates were tested, highlighting the good selectivity to demethoxylation of the optimized catalyst. Afailal et al.[34] have studied the depolymerization of lignin to phenolic compounds in subcritical water together with different reaction media (H_2, CO_2, and HCOOH). The biodiesel oxidation stability time was drastically improved with lignin-derived additives. A comprehensive review on lignin HDO has been written by Kumar et al.,[35] including the following topics: (1) lignin structure depending upon the extraction method, (2) lignin depolymerization (pyrolysis and liquefaction), and (3) HDO of lignin-derived volatiles (*ex situ* or *in situ*). Arroyo et al.[36] have studied the decarboxylation of different fatty acids (stearic, oleic, and palmitic acids) over Pd/zeolite catalysts to produce hydrocarbons, under various conditions (temperature, H_2/N_2, type of zeolite, etc.). They have demonstrated that Pd supported on a hierarchical ZSM-5 zeolite allows for the most selective decarboxylation.

■ HYDROGEN FROM BIOMASS AND WASTES

Condori et al.[37] have compared two low-cost manganese and iron ores for biomass chemical looping gasification in an advanced continuous dual fluidized bed unit. The attrition rate of the two ores, their hydrodynamic behavior in the fluidized bed, and their evolution of composition are discussed in depth after a gasification test of 40+ h time on stream. Santamaria et al.[8] have summarized recent advances in the production of hydrogen by the steam reforming of biomass and waste pyrolysis volatiles. The effect of the catalytic materials (support, promoters, and active phase), synthesis methods, and pyrolysis-reforming conditions on hydrogen yields have been compared. Valecillos et al.[12] have synthesized a $NiAl_2O_4$ spinel for catalytic steam reforming of ethanol in a fluidized bed reactor. The morphology of the carbon deposits (nanotubes) allows for the maintenance of a notable activity with stable formation of H_2 during 48 h.

■ CO_2 AND OTHER TOPICS

Selomon Embaye et al.[38] have reviewed the applications of poly(ether-*block*-amide) (PEBA, commercialized as Pebax) copolymer membranes for CO_2 capture from process streams containing CH_4 and N_2. The chemical and structural characteristics and performances of Pebax membranes according to the different fabrication techniques and parameters are discussed. Tarifa et al.[39] have proposed carbon-based catalysts derived from cellulose as a support to Ni nanoparticles and promoted by Mg and Ce precursors for CO_2 methanation. The stability of the catalyst has been demonstrated by isothermal experiments. The dehydration of methanol to produce dimethyl ether (DME) was studied by Torres-Linan et al.[40] on biomass-derived phosphorus-containing carbon impregnated with a zirconium salt. Highly thermally stable Zr−O−P surface groups were responsible for the high stability and selectivity to DME of the catalyst.

The articles included in this special issue present cutting-edge contributions on bio-oil production and upgrading, novel catalysts, and CO_2 valorization. It mirrors nicely with the pioneering work of Professor Bilbao at the interface between catalyst development and chemical engineering science.

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Notes

Views expressed in this editorial are those of the author and not necessarily the views of the ACS.

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