catalysts

Editorial

Synthesis and Application of Catalytic Materials in Energy and Environment

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Catalytic materials have become prominent in many high-tech fields in recent years [1]. These materials are not categorized according to their nature, bonding form, or processing methods, but rather according to their functions [2,3]. The emergence of catalytic materials in energy (energy storage, conversion, and utilization) [4–12] and environmental (detection, protection, and rehabilitation) applications has received increased attention from both academic and industry scientists [13–20]. Thus, it is necessary to provide a platform for researchers and engineers to discuss the development of catalytic materials in energy and environmental applications. We are honored to serve as the Guest Editors of this Special Issue entitled "Synthesis and Application of Catalytic Materials in Energy and Environment" for the journal *Catalysts*. This Special Issue is focusing on the synthesis, characterization, application, and mechanism analysis of homogeneous and heterogeneous catalysts in energy and environmental applications.

This Special Issue includes sixteen articles in total, out of which fifteen are research articles and one is a review paper. Lu et al. synthesized MoS_2 with a nano-flower-like morphology using sodium molybdate dihydrate and thiourea as molybdenum and sulfur sources [21]. The results show that under the catalytic action of hydrothermal synthesis of MoS_2, the concentration of Cu^{2+} dissolved by ultrasonic treatment for 10 h is 39.46 mg/L. The research article by Dourari et al. focuses on unraveling the effect of MgAl/CuO nanothermite on the characteristics and thermo-catalytic decomposition of nanoenergetic formulation based on nanostructured nitrocellulose and hydrazinium nitro-triazolone. The outstanding catalytic impact of MgAl-CuO on the thermal behavior of developed energetic composites was elucidated using kinetic modeling and applied to the differential scanning calorimetry (DSC) data using isoconversional kinetic methods, for which a considerable drop in the activation energy was acquired for the prepared formulations, highlighting the catalytic influence of the introduced MgAl-CuO nanothermite [22]. Do et al. investigated the effect of a hierarchically ordered macroporous structure of alumina support on the steam reforming of 1-methyl naphthalene using mesoporous alumina-supported nickel and potassium (xK/Ni-MeAl) and macroporous alumina-supported nickel and potassium (xK/Ni-MaAl) catalysts [23]. Hierarchically ordered macroporosity in Al_2O_3 supports play an important role in maintaining the high Ni dispersion through multiple interactions in Ni-K over AlO_4 tetrahedra in alumina. This, in turn, improves the catalytic performance of steam reforming, including high gas yields, the turnover frequency for hydrogen production, and 1-methyl naphthalene conversion [23]. Ge et al. prepared an atomically dispersed cobalt-nitrogen-carbon (Co-N-C) catalyst for the oxygen reduction reaction (ORR) by using a metal-organic framework (MOF) as a self-sacrifice template under high-temperature pyrolysis [24]. The excellent ORR activity is attributed to the high density of the Co-N-C sites with high intrinsic activity and high specific surface area to expose more active sites. Liu et al. prepared a pig-blood-derived mesoporous carbon (BC)

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as a novel Fe-N-C material for the electrochemical detection of hydrogen peroxide [25]. Because of the unique nanostructure of Fe-BCs with rough surface structures, hierarchical pores, and high graphitization degrees, the Fe-BCs, as a kind of advanced electrode material, exhibited remarkable performance in electrocatalysis. Xu et al. fabricated a promising hydroxide/oxide $Co(OH)_2/\alpha$-$NiMoO_4$ NWs/CC heterostructure with nanoflowers decorating the nanowires on a carbon cloth (CC) substrate via hydrothermal and calcination methods [26]. In contrast to one-dimensional nanomaterials, the interfaces of $Co(OH)_2$ nanoflowers and α-$NiMoO_4$ nanowires on CC provide more active sites for electrocatalytic reactions; therefore, they exhibit obviously enhanced electrocatalytic activities in overall water splitting. Yu et al. prepared titanium dioxide–reduced graphene oxide composites (TiO_2-RGO) using a one-step hydrothermal method to degrade different dyes (methyl orange, methylene blue, and rhodamine B) in water [27]. This paper provides a practical avenue to design extremely efficient photocatalysts for dye degradation. The increase in diesel consumption has led to the proliferation of soot particles from diesel exhaust, resulting in pollution in the form of smog. To solve this problem, Liu et al. successfully prepared a series of Ag-doped $Mn_{1-x}Ag_xCo_2O_4$ spinel catalysts using an auto-combustion synthesis method that uses glucose as a fuel [28]. Chen et al. designed a simple strategy to prepare composites that consist of TaON/CdS hybrids via a hydrothermal process [29]. The results show that the pristine CdS nanoparticles loaded with 20 wt% TaON (TC4) could maximize the photocatalytic hydrogen evolution rate to 19.29 mmol g^{-1} h^{-1} under visible light irradiation, which was 2.13 times higher than that of the pristine CdS (9.03 mmol g^{-1} h^{-1}) under the same conditions. Tan et al. successfully prepared $Zn_{1-x}Cd_xS$ catalysts with the Zeolitic Imidazolate Framework-8 (ZIF-8) as the precursor to using an ion exchange method and the ability and electrochemical properties of a series of ZIF-8, ZnS, and $Zn_{1-x}Cd_xS$ catalysts in the photocatalytic degradation of 2-CP and TC were investigated [30]. Four active species, $O_2{}^-$, h^+, -OH, and $SO_4\bullet^-$, can be generated to degrade 2-chlorophenol and tetracycline hydrochloride under PMS-assisted activation. $Zn_{1-x}Cd_xS$ nanocage with high activity and stability provides a feasible approach to catalytically remove persistent pollutants from aqueous solutions under visible light conditions. Metal phase molybdenum disulfide (1T-MoS_2) is considered a promising electrocatalyst for the hydrogen evolution reaction (HER). Wei et al. developed the 1T-MoS_2/NiS heterostructure as an interface engineering-induced strategy for the hydrogen evolution reaction (HER) [31]. This work demonstrates that tuning the electronic structure through interface engineering to enhance the intrinsic activity of electrocatalysts is a feasible strategy. Wang et al. reported a novel strategy of improving the midpoint voltage and structural stability of Li-rich manganese-based cathode material by increasing the nickel content [32]. Li et al. prepared La^{3+} and Ni^{2+}-doped BiOCl using a sol–gel method and characterized by physicochemical and spectroscopic techniques. The photocatalytic performances were investigated by the degradation of gentian violet under visible light. The bandgap of BiOCl declined after doping; the results of PL and EIS demonstrated that the La- and Ni-Co-doped BiOCl effectively enhanced the transfer and separation of photogenerated electrons and holes. Therefore, the Ni and La co-doped BiOCl exhibited the best catalytic performance with a catalytic degradation efficiency of 95.5% in 105 min [33]. Jiang et al. reported a strategy to prepare Pt/Pd nanoparticles decorated with Co-N-C materials, where Co-N-C was obtained directly via the pyrolysis of ZIF-67. The as-prepared Pt/Pd/Co-N-C catalysts showed excellent ORR performance, offered with a higher limit current density (6.6 mA cm^{-2}) and similar half-wave potential positive ($E_{1/2}$ = 0.84 V) compared with commercial Pt/C. In addition to the ORR activity, it also exhibits robust durability [34]. Zhao et al. developed a novel route for the rapid and high-yield synthesis of mordenite (MOR) zeolite via an ice-templating method [35]. In comparison to traditional hydrothermal synthesis, the high yield, the superior crystallinity, and the large reduction in the water level and reaction pressure indicate that simple device and conventional silica sources by this route have great potential for the commercial production of pure MOR zeolite. Moreover, the changed bonding environment of silicon atoms in MOR zeolite remarkably enhances its acid strength; this is because of the relative decrease in the tetrahedrally coordinated Si-O-Si bond and, accordingly, the increase in the T-OH (T = Si, Al) groups and Si-O-Al sites. Han et al. summarized the research progress of noble metal (Pt, Pd, Au, Ag, and Ir) catalysts for the removal of VOCs in recent years with the discussion of the influence factors in the preparation process on the catalytic performance [36]. The reaction mechanisms of the removal of VOCs over the corresponding noble metal catalysts were also briefly discussed.

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