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EDITORIAL

Catalytic Ordered Transformation for New Energy Exploitation and Application

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Catalytic ordered transformation (COT) is a chemical reaction that involves conversion of certain chemical compounds into other forms of products over selective catalysts. COT plays an important role in many research fields such as energy, environment and chemistry, using catalysts to promote high yields of specific products with less environmental pollution. In recent years, COT has captured a great attention due to strict regulations in the environmental protection laws and high demand of product yield by the industries. In addition, over the past decades, COT's research publications have dramatically increased, especially with respect to the homo-/heterogeneous oxidative dehydrogenation of propane (ODHP), the abatement of volatile organic compounds (VOCs), NOx selective conversion, Fischer-Tropsch (FT) synthesis and methane reforming (dry and steam reforming). Therefore, COT needs to be further explored, including the active and stable catalysts, preparation strategies, comprehensive characterizations and surface mechanisms from both experimental and kinetic modeling point of view.

Different kinds of catalysts have been employed for COT in new energy exploitation and application, which are commonly based on noble metals (Ag, Au, Pd, Pt, Rh and Ru), transition metal oxides (Ce, Co, Cr, Cu, Fe, Mn, Mo, Ni, Ti, V, Zn and Zr) and their mixtures (binary/ternary oxides), perovskites, zeolites, hydrotalcite as well as single-atom catalysts.

Several preparation techniques were involved in COT, containing the liquid-/vapor-/solid-phase methods. The liquid-phase preparation techniques involve sol-gel, hydrothermal, precipitation, microemulsion, microwave, electro-chemical and high temperature techniques. The vapor-phase preparation techniques consist of spray pyrolysis, chemical vapor deposition (CVD), pulse spray evaporation CVD, atomic layer deposition (ALD), magnetron sputtering and plasma methods. The solid-phase preparation techniques include high temperature, flux growth, combustion, nitrate decomposition, MOF-derived and pulsed laser methods [1].

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To understand the physico-mechanical properties of the COT catalysts such as crystalline phases, morphology, microstructure, chemical composition, ionic state, surface area, structural stability, the pore structure and catalytic performance, different characterization methods have been employed. Among those techniques, XRD, SEM, HIM, TEM, EDS, XPS, BET, H_2-TPR, TGA, FTIR, MS, EXAFS, XANES, EELS, DRIFTS and N_2-physisorption were used. In the past years, studies have presented that the catalysts used in COT suffered from some drawbacks due to carbon deposition, sulfur poisoning, alkali poisoning, and the presence of water, which tend to deactivate the catalysts during application. Recent works also reported how catalytic performance was improved by considering some strategies like resistance to sulfur, support effect, alkali, water, promoters, and active metal loadings on the catalysts. The COT reaction mechanism, selective catalytic reduction, reforming, and FT synthesis were also studied recently.

Despite of the present works, a lot of works remains further study for COT in new energy exploitation and application: 1) the tailored design of more stable, efficient, selective, and cost-effective COT catalysts; 2) advanced synthesis methods to correlate the thickness, morphology and ionic states; 3) application of COT in energy storage and conversion; 4) the effects of CO_2 and water vapor adsorption on the surface of COT catalyst; 5) studies on the mixture of NOx, SOx and VOCs to reproduce the real emission control; 6) studies on MnOx as catalyst support for FT synthesis and methane reforming due to its sulfur and water-resistant effect; 7) controlled synthesis of single-atom catalysts for steam methane reforming and FT synthesis; 8) studies on the conversion of low-cost industrial by-product to high demand chemical product like dehydrogenation ethane to ethylene and ODHP; 9) studies on the reaction pathway control that will reduce secondary reaction intermediates to achieve the desired product; 10) theoretical calculations of the thermo data of surface species and rate constants of heterogeneous reactions [1].

Conflict of Interest

There is no conflict of interest.

References

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