Innovation in Complex Metal Oxide Catalysts for Selective Oxidation

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Abstract: Complex metal oxides with multi-elemental constituents in structures are one of the key solid-state catalytic materials, particularly for catalytic selective oxidation in gas-phase and even in liquid phase. In the past years many types of complex metal oxide catalysts have been developed, for example multi-phasic materials for catalytic olefin oxidation, crystalline solid based on group 5 elements for alkane oxidation, molecular-type complex oxide, so called polyoxometalates, for various kinds of oxidation, and cation-containing or -occluding silica-based zeolites for H_2O_2 oxidation and more recently for gas-phase methane partial oxidation(Figure 1, left). The fundamental aspect in these complex metal oxide catalysts is that multi-catalytic functions can be generated by the collaboration among the constituents in atomic-level structure or arrangement. We should expect more innovative catalytic functions based on the collaboration if the mutual position of each element is finely tuned in crystal structure of complex metal oxides. We should expect much more high level functions if complex metal oxides have a crystal structure-based porous property, because not only the surface elements but also the element in the bulk, in other word all of the constituent elements, can participate in catalytic reaction and also more importantly because mutual elemental position is uniform in the whole crystalline catalytic material. This crystalline state in the complex metal oxides must be the ideal situation in catalytic materials. However difficulty is how to synthesize these materials. Catalysis researchers should not distract their attention from this difficulty and even work challengingly on developing new synthetic methodology for new crystalline complex metal oxides. Our research group has long studied on this issue and fortunately has been able to create new materials that can satisfy the above-mentioned demands. These are new porous crystalline complex metal oxides based on group V and VI elements as shown in Figure 1, right. The underline concept in the synthesis of these materials is the construction of three-dimensional structures with structural units, so-called unit synthesis (unit-assembling). This synthetic protocol is still not in the level of structure designing at present but will be progressed by the assistance of computer modeling.

Keywords: Complex metal oxide, selective oxidation, structure synthesis, porous structure

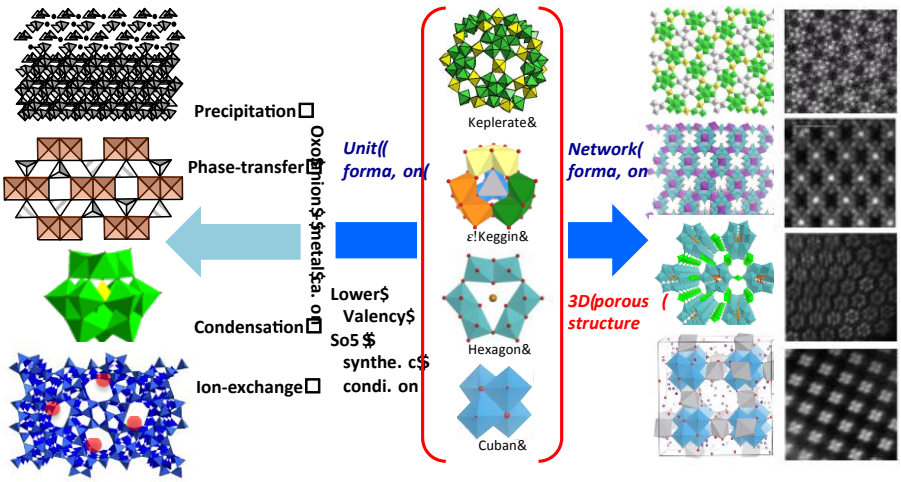

Figure 1 Typical complex metal oxides for selective oxidation and new porous crystalline complex metal oxides synthesized through unit-assembling