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Synthesis and Characterization of silica supported metal modified Mo-based catalyst for dry methane reforming

Methane reforming reactions are currently used to produce synthesis gas and/or hydrogen. Due to the increase on H₂ demand and the importance of synthesis gas for further reactions, the role of methane reforming catalysts have recently become more important. Among these reactions, the carbon dioxide reforming of methane (dry reforming : DMR) is of great interest since it allows production of H₂/CO ratios suitable for the synthesis of a wide variety of valuable hydrocarbons and oxygenates. However, since the dry reforming is a highly endothermic reaction, Eq.(1), it has to be performed at high temperature and low pressure to achieve maximum conversions.



The dry reforming reaction is accompanied by several side reactions, of which the reverse water gas shift reaction (RWGS) Eq.(2), the methane cracking reaction Eq. (3) and the Boudouard reaction Eq. (4) appears to be the most important:



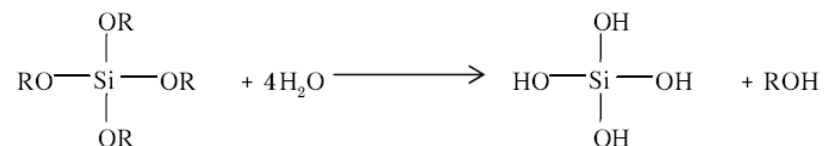
Note that, under typical reforming conditions, DMR are shown as irreversible in the above equations, while RWGS is shown as reversible, reflecting thermodynamic potentials at typical reforming conditions.

Supported MoO₃ is an important catalyst or catalyst precursor in a number of industrially relevant reactions such as oxidation, dehydrogenation, oxidative dehydrogenation, isomerization and metathesis. Among transition metal ions incorporated into meso- or microporous silica,

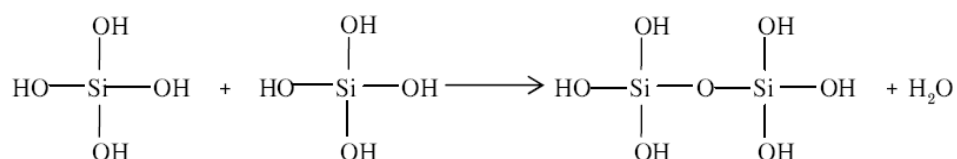
molybdenum is one of the most studied, due to its interesting catalytic properties in many reactions. On the one hand, molybdenum is used in the petroleum chemistry (hydrocracking, hydrodesulfurization, etc.), which is the subject most studied. On the other hand, it has been incorporated into mesoporous molecular sieves (M41S, SBA-n, silicalites, etc.) by wetness, dry impregnation, thermal spreading, grafting, insertion or sol-gel

Sol-gel processes have attracted the attention of many researchers in recent years. In fact, the physical and chemical features of the materials obtained by these methods (e.g., particle sizes, surface areas and mechanical properties) can be changed according to the temperature, operating conditions and to the used precursor. Besides, the sol-gel process has been successfully employed to prepare glassy materials, ceramic powders, dense or porous ceramic pieces, deposition of thin films and biosensors construction. The obtained materials emerging from these processes also can be used in selective heterogeneous catalysis, which represents an area of great economical interest. Nowadays, sol-gel methods are well established, allowing the preparation of a broad variety of supported metals, metal oxides, coatings and composite materials with tailored properties.

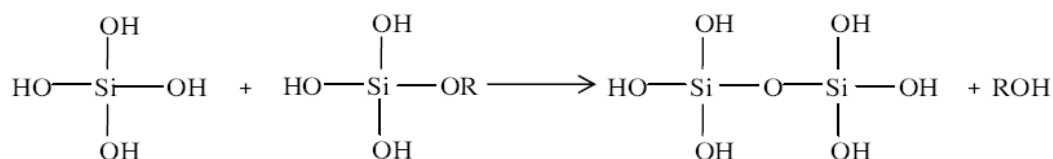
Hydrolysis :



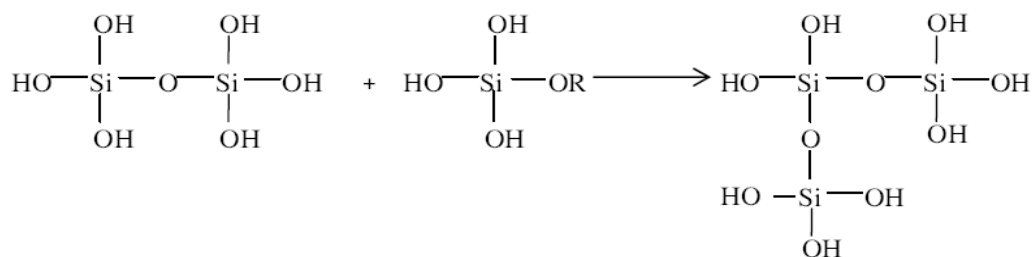
Water Condensation :



Alcohol Condensation :

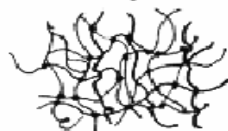


Polymerisation :



These sol-gel processes have been used to prepare supported metal catalysts and catalyst supports with higher thermal stability, higher resistance to deactivation while allowing a better flexibility in controlling catalyst properties such as particle size, surface area and pore size distribution. Many authors report the sol-gel route as the best way to disperse catalytic metals on gels of finely texture.

(a) Acid catalysis



Wet gel (schematic)



xerogel (schematic)



TEM (bar=25nm)

(b) Base catalysis



Wet gel (schematic)



xerogel (schematic)



TEM (bar=100nm)

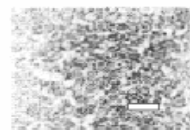
(c) Base-catalyzed colloidal



hierarchical

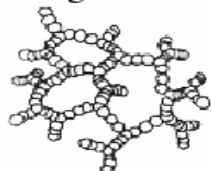


random packing

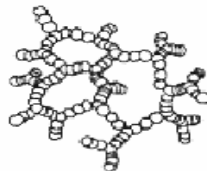


TEM (bar=100nm)

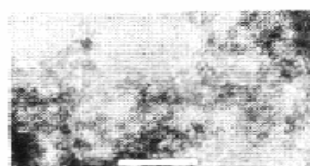
(d) Aerogel



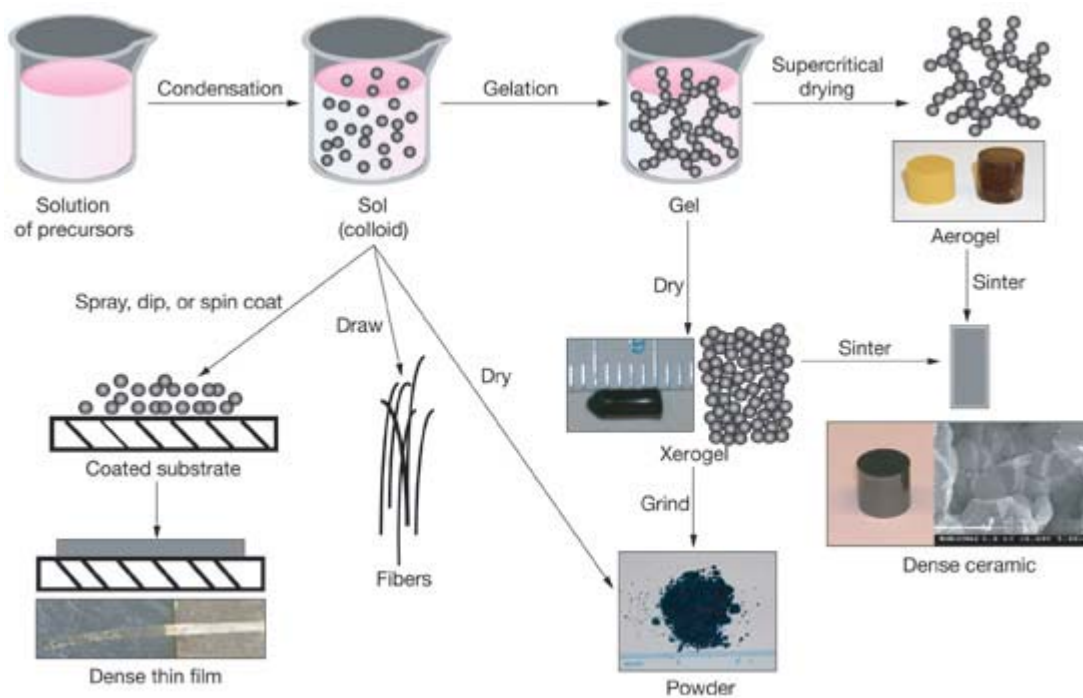
Wet gel (schematic)



dried gel (schematic)



TEM (bar=50nm)



http://www-cmls.llnl.gov/?url=science_and_technology-chemistry-solgel_chemistry