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BIMETALLIC ACETATE COMPLEXES DERIVED LA(III)-DOPED TIO_2 NANOFIBERS FOR CLAUS CATALYSTS

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Modified Titania is of great interest for industrial catalysts and photocatalysts with applications in environmental engineering. In this research, La(III) was incorporated into titanium oxoacetate complexes via a one pot sol-gel process of metal alkoxides reacting with acetic acid, evidenced by electrospray ionization mass spectrometry analysis. The resulting well-defined nanofibers were calcined to obtain 1-dimensional La-doped TiO_2 materials. For comparison, lanthanum was also deposited on the surface of TiO_2 nanofibers by an impregnation method. X-ray photoelectron spectroscopy analysis shows that the oxygen defect in the La-doped sample was more significant than that in the La-deposited TiO_2. In addition, more interaction of lanthanum with the TiO_2 matrix was observed in the nanofibers synthesized via the sol-gel method. These features of doped TiO_2 nanofibers are anticipated to play a role in higher catalytic activity. In addition, both the La-doped and deposited TiO_2 nanofibrous materials exhibited excellent thermal stability. The N_2-physisorption and powder x-ray diffraction characterizations show that both anatase crystallites and surface areas in the lanthanum-modified TiO_2 were maintained better than the unmodified counterparts at temperatures up to 900°C. As a cleaner energy resource, natural gas provides about 30% energy consumption and more than 27% electricity generation in North America. However, many natural gas reservoirs contain H_2S, which needs to be removed by amine scrubbing followed by a Claus process. With pending stricter emission policies and lower commodity prices, it is urgent for natural gas producers to seek more efficient Claus catalysts. In this context, lanthanum-modified TiO_2 was tested as a Claus catalyst and a better performance was observed than the unmodified TiO_2. We attributed the promoted catalytic activity of La-modified TiO_2 to the M^{3+} cations, which causes oxygen defects in TiO_2 and thereby increases SO_2 adsorption capacity. A higher SO_2 adsorption on the catalytic surface enhances both H_2S and CS_2 conversion. In addition, sulfate concentrations in the used catalysts were studied to explain the catalytic activities.

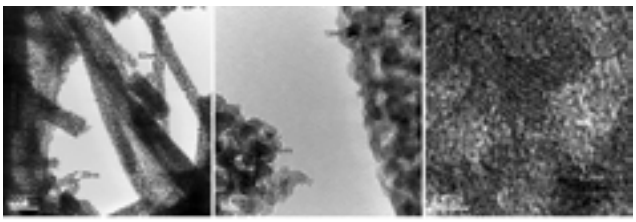

Figure 3. TEM images of La(III)/TiO_2 calcined at 500 °C with increased magnifications from left to right. Left panel: nanofibers with diameters ca. 30 nm. Middle panel: the nanofibers are composed of nanocrystallites less than 18 nm. Right panel: the signature anatase lattice fringe patterns.

Recent Publications

1. Sui R, Marriott R, et al. (2017) Organo sulfur adsorbents by self-assembly of titania based ternary metal oxide nanofibers. Journal of Materials Chemistry 5:9561-9571.
2. Sui R, Marriott R, et al. (2016) Selective adsorption of thiols using gold nanoparticles supported on metal oxides. Langmuir 32:9197-9205.
3. Clark P, Sui R, et al. (2013) Oxidation of CO in the presence of SO_2 using gold supported on La_2O_3/TiO_2 nanofibers. Catalysis Today 207:212-219.
4. Sui R and Charpentier P (2012) Synthesis of metal oxide nanostructures by direct sol–gel chemistry in supercritical fluids. Chemical Reviews 112:3057-3082.
5. Sui R, Berlinguette C, et al. (2008) Simple protocol for generating TiO_2 nanofibers in organic media. Chemistry of Materials 20:7022-7030

Biography

Ruohong Sui has his expertise in making metal oxide nanomaterials using a sol-gel process. He is interested in self-assembly of metal-ligand complexes to make 1- and 2-dimensional nanomaterials in non-aqueous media, and using the resulting materials for clean energy applications.

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