

## MASTER'S THESIS

### Study of the effect of gold, platinum and vanadium oxide additives on the activity of TiO<sub>2</sub>-ZrO<sub>2</sub> mixed oxide for the decomposition of CFC-22

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*Date of Award:*  
2002

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Study of the Effect of Gold, Platinum and Vanadium Oxide  
Additives on the Activity of  $\text{TiO}_2\text{-ZrO}_2$  Mixed Oxide for  
the Decomposition of CFC-22

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A thesis submitted in partial fulfillment of the requirements  
for the degree of  
Master of Philosophy

March 2002

Hong Kong Baptist University

## ABSTRACT

It was found that sulfate promoted  $\text{TiO}_2\text{-ZrO}_2$  had high activity for the hydrolytic decomposition of dichlorodifluoromethane (CFC-12), giving carbon dioxide as the major carbon-containing product. The acidity of the catalyst was one of the main factors affecting its activity. With chlorodifluoromethane (CFC-22), the carbon-containing product of hydrolysis over the mixed oxide is mainly carbon monoxide, which is a toxic air pollutant. With the aim of directing the selectivity to carbon dioxide, we studied the decomposition of CFC-22 in air in the presence of water using gold, platinum or vanadia supported on the sulfate promoted  $\text{TiO}_2\text{-ZrO}_2$  mixed oxide. Gold and platinum were selected for the investigation since it is well known that gold prepared as supported nanometer size particles, and Pt can oxidize CO to  $\text{CO}_2$  and  $\text{V}_2\text{O}_5$  highly dispersed on titania (anatase) has good activity for partial oxidation of methanol and other oxidative reaction.

The gold support catalysts were prepared by decomposition-precipitation method, and Pt catalysts and vanadia catalysts were prepared by impregnation method.

From all of the result already obtained, treatment with dilute ammonium sulfate solution increased the acidity and Bronsted acid sites of the catalysts, thus the activity of the catalyst increased. Impregnation with concentrated sulfuric acid led to the change of a large fraction of the catalysts from the columbite structure to anatase structure and surface area of catalyst decreased. The activity decreased although the acidity and Bronsted acid sites of the samples increase significantly. Therefore, columbite crystal structure influences the activity of the decomposition of CFC-22. The more columbite phases result in the higher activity of the catalyst for CFC-22 decomposition.

Gold / support catalysts, on which the CO oxidation take place at low temperature, did not improve selectivity of the catalyst to CO<sub>2</sub> significantly. On the contrary, the activity of the catalysts for CFC-22 decomposition decreased on these catalysts relative to the catalysts without adding gold. It is because the acidity of the catalyst decreased by treating the catalysts with basic solutions and the existence of halide inhibited the CO oxidation on the gold. Pt / support catalyst enhanced the selectivity of the CFC-22 decomposition for carbon dioxide. The catalyst Pt/TZ with Pt(0) had the best selectivity to CO<sub>2</sub> for CFC-22 decomposition. The activity of the catalysts after promotion with platinum decreased.

Addition of vanadia deactivated the catalysts. The increase of the vanadia loading made this deactivation more serious. XRD results indicated the existence of VO<sub>2</sub> on TZ and TZNS and V<sub>2</sub>O<sub>5</sub> on TZS when vanadia loading was at 12%. XPS results also proved that the oxidation states of vanadium on V-TZ and V-TZNS are lower than that on V-TZS. The factor that influences the deactivation of catalysts is mainly vanadia loading. The content of vanadia increased, the activity of V-TZ and V-TZNS for CFC-22 decomposition decreased. But among V-TZS catalysts, V6-TZS had the best activity. Addition of vanadia improved the selectivity to CO<sub>x</sub>, but not enhanced the selectivity to CO<sub>2</sub> for CFC-22 decomposition significantly. V6-TZ had the best selectivity to CO<sub>2</sub> among all the vanadia doped catalysts.

Among all of catalysts, Pt/TZ catalysts have the best selectivity to CO<sub>2</sub> for CFC-22 decomposition and higher stability although its activity for this reaction is not the highest.

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