Selective Catalytic Oxidation of Trimethylamine over Support Gold Catalysts at Low Temperature

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Trimethylamine (N(CH$_3$)$_3$), a nitrogen-containing volatile organic compounds with a strong fishy odor at low concentrations and an ammonia-like odor at higher concentrations, has been considered to be a strong environmental pollutant because of its moderately toxic by inhalation and its likely carcinogenic properties. Selective catalytic oxidation (SCO) of N(CH$_3$)$_3$ to harmless products at low temperatures has been considered to one of the most promising method to remove N(CH$_3$)$_3$. Au/NiFe$_2$O$_4$ has been reported to give a T$_{1/2}$ of 115$^\circ$C which was the most active and selective catalyst ever reported for N(CH$_3$)$_3$-SCO while N$_2$O was mostly produced over Pd and Pt catalysts even at higher temperatures1. On the aspect of saving energy and producing environment-friendly products, it is essential to develop efficient catalysts for low-temperature N(CH$_3$)$_3$-SCO.

The catalytic activity depends on both the size of gold nanoparticles and the type of supported metal oxides. CeO$_2$ which is a reducible metal oxide with high oxygen storage capacity and an acidic metal oxide Nb$_2$O$_5$ were chosen as the supports because N(CH$_3$)$_3$ belongs to amine group. CeO$_2$ with two different BET surface area of 114 m$^2$/g and 20 m$^2$/g (denoted as CeO$_2$-114 and CeO$_2$-20) were used as the supports. Au/CEO$_2$ catalysts were prepared by deposition precipitation method2. Nb$_2$O$_5$ with two different crystal structures (layered-structure-type and amorphous, denoted as Nb$_2$O$_5$-L and Nb$_2$O$_5$-A) were chosen as the supports and Au/Nb$_2$O$_5$ catalysts were prepared by sol immobilization method2,3. The amount of catalyst used was 0.15 g. The reactant gas contained 50 ppm N(CH$_3$)$_3$ and 20% O$_2$ balanced with Ar was passed through the catalytic bed.

As shown in Fig.1, the catalytic activity decreased in the order of Au/Nb$_2$O$_5$-L > Au/Nb$_2$O$_5$-A > Au/CEO$_2$-114 > Au/CEO$_2$-20. Au/Nb$_2$O$_5$-L showed the highest catalytic activity for N(CH$_3$)$_3$ oxidation that can be attributed to the lattice oxygen species on Au/Nb$_2$O$_5$-L which is good for the formation of active atomic oxygen species. Moreover, Au/Nb$_2$O$_5$-L showed a very good selectivity to N$_2$ with yielding zero NH$_3$ and N$_2$O while NH$_3$ and N$_2$O were mostly produced over Au/CEO$_2$-114 and Au/CEO$_2$-20 at T$_{1/2}$. Besides, Nb$_2$O$_5$-L and Nb$_2$O$_5$-A showed no catalytic activity for N(CH$_3$)$_3$ oxidation from temperatures ranging from 25$^\circ$C to 140$^\circ$C which indicated that catalytic activity was significantly enhanced by the deposition of Au nanoparticles. In conclusion, Au/Nb$_2$O$_5$-L is the promising candidates for realizing N(CH$_3$)$_3$-SCO at low temperature.

**Figure 1.** Effect of reaction temperatures on N(CH$_3$)$_3$ conversion over different metal oxide supported gold catalytic. The gold loading amount is 1wt%.

**References**


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