Hydroformylation of Vinyl Acetate and Cyclohexene over TiO₂

Nanotubes Supported Rh and Ru Nanoparticles Catalysts

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S. 1 GC analysis of the product in vinyl acetate hydroformylation

The hydroformylation of vinyl acetate might provide two functional products: 2-acetoxy propanal and 3-acetoxy propanal. In our experiment, the products were analyzed using GC analysis and analytical conditions were described as follows:

Injection temperature: 260 °C; detector temperature: 265 °C.

Temperature program: 45 ° C, keep for 3 mins; ramp 1, 2 °C/min to 60 °C, keep for 0 mins;

ramp 2, 25 °C/min to 250 °C, keep for 5 min.

S.1 are the GC profiles of the sample come from the hydroformylation of vinyl acetate over catalyst Rh-Ru/TNTs (8 h). The black line is the result of the sample before reaction and the pink one is after reaction. The peaks with different retention time are listed as follows:

Substrate: vinyl acetate, retention time (RT): 1.755 min;

Solvent: toluene, RT: 5.009 min;

Product: 2-acetoxy propanal, RT: 5.660 min. No peak for 3-acetoxy propanal.

From S. 1, we can see easily that after reaction, all the vinyl acetate was consumed and there was only one main product 2-acetoxy propanal.





S. 2 GC analysis of the product in cyclohexene hydroformylation

In the hydroformylation process of cyclohexene, the main product is aldehyde, and a small quantity of aldehyde will be further reduced to alcohol. The products were analyzed using GC analysis and analytical conditions were described as follows:

Injection temperature: 170 °C; detector temperature: 175 °C.

Temperature program: 45 ° C, keep for 3 mins; ramp 1, 2 °C/min to 60 °C, keep for 0 mins;

ramp 2, 25 °C/min to 250 °C, keep for 5 min.

S. 2 are the GC profiles of the sample come from the hydroformylation of cyclohexene over catalyst Rh-Ru/TNTs (8 h). The black line is the result of the sample before reaction and the pink one is after reaction. The peaks with different retention time are listed as follows:

Substrate: cyclohexene, retention time (RT): 2.992 min;

Solvent: toluene, RT: 4.994 min;

Product: aldehyde RT: 11.561 min; alcohols RT: 13.134.

From S. 2, we can see clearly that all the cyclohexene was used up after reaction and only a small quantity of alcohol generated.



S. 2 Gas chromatogram of cyclohexene hydroformylation before and after reaction

S. 3 SEM and EDX elemental mapping analysis for the catalysts

S. 3. 1 Rh/TNTs





2.5µm

S. 3. 2 Ru/TNTs





S. 3. 3 Rh-Ru/TNTs



2.5µm





2.5µm

S. 3. 4 Ru-Rh/TNTs



1µm





S. 3. 5 Rh-Ru/TNTs (200 ℃)



1µm





S. 4 XPS survey spectra of catalysts





