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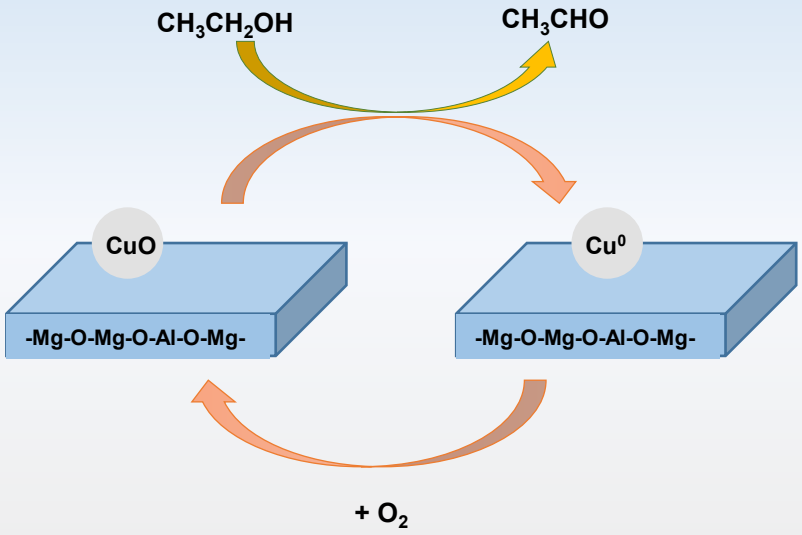
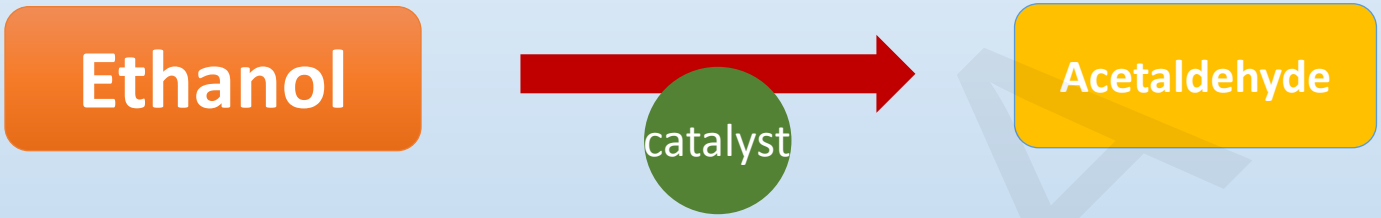
Oxidative dehydrogenation of ethanol over Cu/Mg-Al catalyst derived from hydrotalcite: effect of ethanol concentration and reduction conditions

Key words:

oxidative dehydrogenation, ethanol, copper, Mg-Al hydrotalcite, acetaldehyde, catalyst





- The oxidative dehydrogenation of ethanol to acetaldehyde over the mixed oxide obtained from hydrotalcite provided relatively low yield. Hence, to promote the catalytic activity, the modification of mixed oxide is crucial.

- The effect of copper-modification on the catalytic activity of Mg-Al oxide obtained from the hydrotalcite were elucidated.

- The effect of water on the catalytic activity and the effect of reduction condition were also examined.

Methodology

- **Investigation of the effect of copper-modification, the effect of ethanol concentration and reduction condition of copper-modified Mg-Al catalyst on catalytic activity.**

Co-precipitation and incipient wetness impregnation

Techniques

XRD, N_2-physisortion, CO_2-TPD, ICP, H_2-TPR

Ethanol Reaction

- Oxidative dehydrogenation at 200 – 400°C
- Stability test (TOS)
- Ethanol concentration (99.9%, 75%, 50%)
- Reduction temperature (300°C and 400°C)

Effect of copper and water content

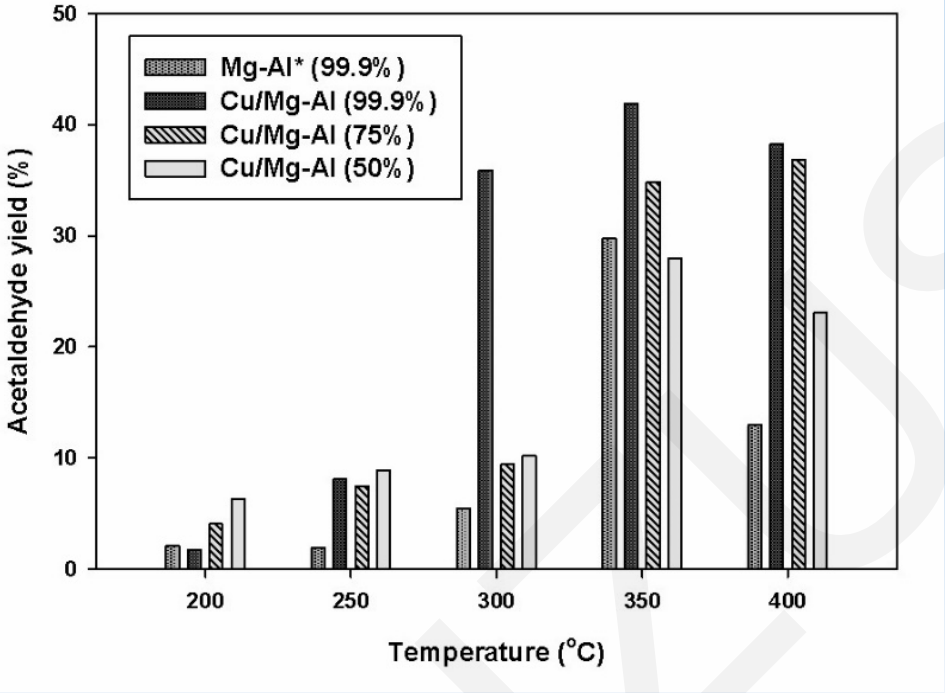


Fig. 1 Acetaldehyde yield of the Cu/Mg-Al catalyst under different ethanol concentrations. *Values of Mg-Al catalyst are obtained from the previous work (Pinthong *et al.*, 2019).

- Copper can promote the catalytic activity of Mg-Al catalyst.
- The Cu/Mg-Al catalyst shows the highest acetaldehyde yield of 41.8% at 350°C.
- The presence of water negatively affects the catalytic activity on the Cu/Mg-Al catalyst.
- This negative effect decreased at high temperature (350-400°C).

Effect of reduction temperature

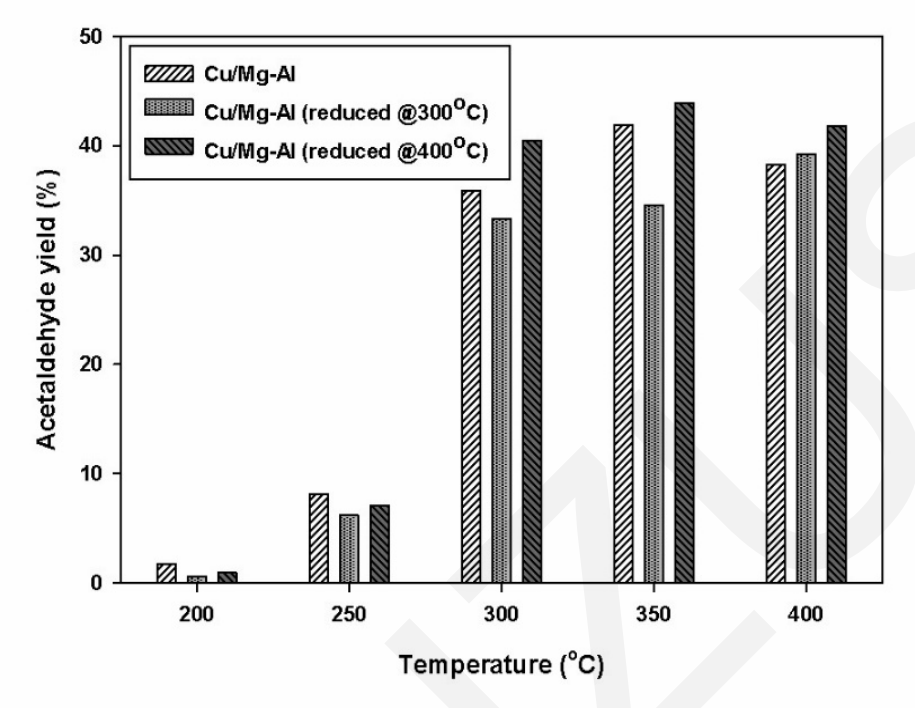
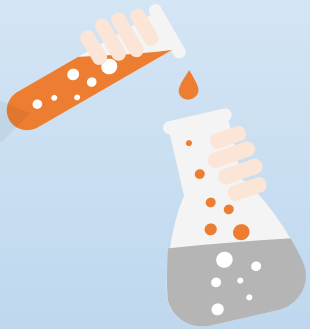


Fig. 2 Acetaldehyde yield of the Cu/Mg-Al catalyst under different reduction conditions.

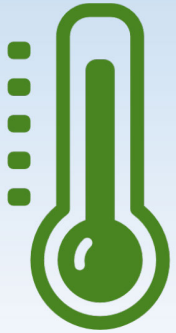
- The non-reduced catalyst exhibits higher acetaldehyde yield than the reduced catalysts.
- the reduction step of the Cu/Mg-Al catalyst is not necessary in the oxidative dehydrogenation reaction of ethanol.

Conclusions



- The activity of the copper-modified catalyst increases remarkably, especially at 300–400°C. The maximum acetaldehyde yield was 41.8% at 350°C.

- The water content greatly affects the catalytic performance of the Cu/Mg-Al at 300°C. The ethanol conversion decreased about 6-fold due to the competitive adsorption of water molecule. The negative effect decreased at high temperature (350-400°C).



- The reduction step showed insignificant effect on catalytic activity of Cu/Mg-Al.

The Cu/Mg-Al catalyst can be used as a promising catalyst in the oxidative dehydrogenation of ethanol to acetaldehyde without any reduction step. Moreover, it can be used effectively in this reaction for the diluted ethanol at a temperature range of 350–400°C.