

## Supplementary Information

(SI)

### **Dimethyl ether steam reforming to produce H<sub>2</sub> over Ga-doped ZnO/ $\gamma$ -Al<sub>2</sub>O<sub>3</sub> catalysts**

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## 1. Experimental Section

The thermal gravimetric analysis (TG) was performed on a PerkinElmer Diamond TG/DTA instrument. About 10 mg sample was heated from room temperature to 900 °C in air at a heating rate of 10 °C /min.

The temperature-programmed desorption of ammonia (NH<sub>3</sub>-TPD) was Before the NH<sub>3</sub>-TPD test, the catalyst was first pretreated at 500 °C for 1 h in He (99.999%, 80 mL/min). The sample was cooled to 100 °C in the same atmosphere. Then, the atmosphere was switched to 5% NH<sub>3</sub> in N<sub>2</sub> for 2 h NH<sub>3</sub> adsorption at 100 °C. After flushing with pure He, the NH<sub>3</sub>-TPD test was carried out in the range of 100–600 °C at a heating rate of 10 °C /min. The signal was monitored by a gas chromatograph equipped with a TCD detector (XianQuan TP-5079 instrument).

## 2. Results and discussion

### 2.1. TPD-MS-CH<sub>3</sub>OH with the adsorption of CH<sub>3</sub>OH at 100 °C on ZnO

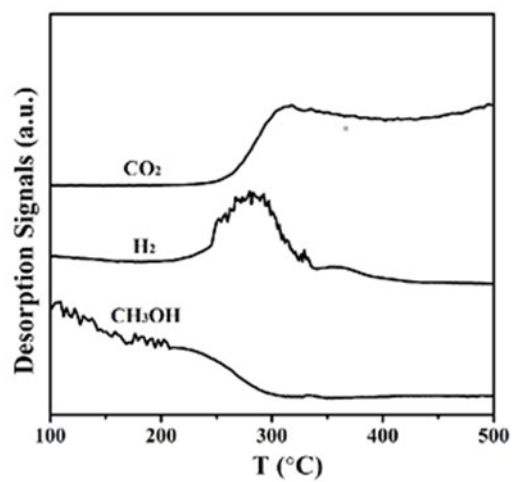


Fig. S1 The signals of TPD-MS-CH<sub>3</sub>OH with the adsorption of CH<sub>3</sub>OH at 100 °C on ZnO.

## 2.2. Arrhenius plots for DME SR reaction over GDZ/ $\gamma$ - $\text{Al}_2\text{O}_3$ catalysts

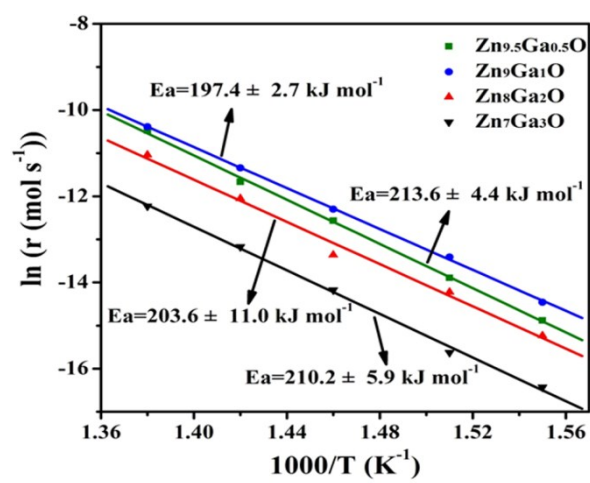


Fig. S2. Arrhenius plots for DME SR reaction over GDZ/ $\gamma$ - $\text{Al}_2\text{O}_3$  catalysts

### 2.3. XRD of the $\text{CuZnAlO}/\gamma\text{-Al}_2\text{O}_3$ and $\text{Zn}_9\text{Ga}_1\text{O}/\gamma\text{-Al}_2\text{O}_3$ catalysts before and after stability test

The XRD patterns of  $\text{Zn}_9\text{Ga}_1\text{O}/\gamma\text{-Al}_2\text{O}_3$  and  $\text{CuZnAlO}/\gamma\text{-Al}_2\text{O}_3$  catalysts before and after stability tests are shown in Fig. S3. For the  $\text{CuZnAlO}/\gamma\text{-Al}_2\text{O}_3$  catalyst, the diffraction peaks of the metallic Cu in the catalyst after stability test are much sharper and higher than the catalyst before stability test. It suggests the serious sintering of the metallic Cu. For the  $\text{Zn}_9\text{Ga}_1\text{O}/\gamma\text{-Al}_2\text{O}_3$  catalyst, the strength of the diffraction peaks of the catalyst after stability test has little change compared with the catalyst before stability test, indicating that the  $\text{Zn}_9\text{Ga}_1\text{O}/\gamma\text{-Al}_2\text{O}_3$  catalyst almost did not sinter during DME SR reaction.

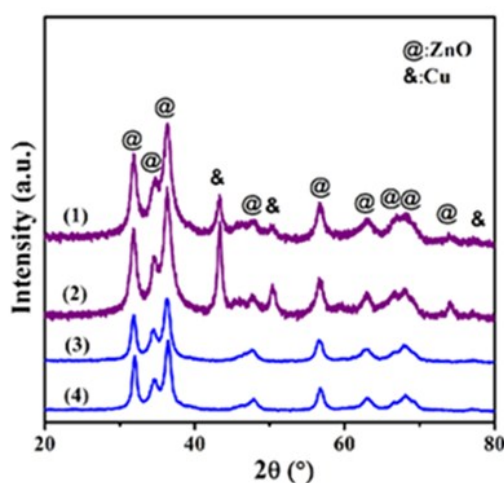


Fig. S3 XRD patterns of the  $\text{CuZnAlO}/\gamma\text{-Al}_2\text{O}_3$  and  $\text{Zn}_9\text{Ga}_1\text{O}/\gamma\text{-Al}_2\text{O}_3$  catalysts before and after stability test: (1)  $\text{CuZnAlO}/\gamma\text{-Al}_2\text{O}_3$  catalyst before stability test, (2)  $\text{CuZnAlO}/\gamma\text{-Al}_2\text{O}_3$  catalyst after stability test, (3)  $\text{Zn}_9\text{Ga}_1\text{O}/\gamma\text{-Al}_2\text{O}_3$  catalyst before stability test, (4)  $\text{Zn}_9\text{Ga}_1\text{O}/\gamma\text{-Al}_2\text{O}_3$  catalyst after stability test.

## 2.4. TG of the $\text{CuZnAlO}/\gamma\text{-Al}_2\text{O}_3$ and $\text{Zn}_9\text{Ga}_1\text{O}/\gamma\text{-Al}_2\text{O}_3$ catalysts before and after stability test:

To determine coke deposition over the  $\text{CuZnAlO}/\gamma\text{-Al}_2\text{O}_3$  and  $\text{Zn}_9\text{Ga}_1\text{O}/\gamma\text{-Al}_2\text{O}_3$  catalysts after stability test, the thermal gravimetric analysis (TG) experiments are shown in Figure S4. The weight loss below 300 °C is ascribed to the loss of adsorbed water. The weight loss above 300 °C is related to the coke removal via the reaction  $\text{C} + \text{O}_2 \rightarrow \text{CO}_2$ . Compared with the catalyst before stability test, the  $\text{Zn}_9\text{Ga}_1\text{O}/\gamma\text{-Al}_2\text{O}_3$  catalyst after stability test has no additional weight loss above 300 °C. So, we can conclude that no coke deposition is formed during the stability test. However, compared with the  $\text{CuZnAlO}/\gamma\text{-Al}_2\text{O}_3$  catalyst before stability test, the  $\text{CuZnAlO}/\gamma\text{-Al}_2\text{O}_3$  catalyst after stability test has about 1.5 % of additional weight loss above 300 °C, indicating that some coke is deposited on the  $\text{CuZnAlO}/\gamma\text{-Al}_2\text{O}_3$  catalyst during the stability test.

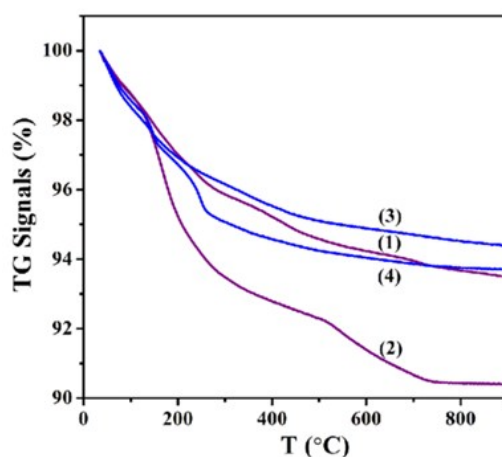


Fig. S4 TG of the  $\text{CuZnAlO}/\gamma\text{-Al}_2\text{O}_3$  and  $\text{Zn}_9\text{Ga}_1\text{O}/\gamma\text{-Al}_2\text{O}_3$  catalysts before and after stability test:

(1)  $\text{CuZnAlO}/\gamma\text{-Al}_2\text{O}_3$  catalyst before stability test, (2)  $\text{CuZnAlO}/\gamma\text{-Al}_2\text{O}_3$  catalyst after stability test, (3)  $\text{Zn}_9\text{Ga}_1\text{O}/\gamma\text{-Al}_2\text{O}_3$  catalyst before stability test, (4)  $\text{Zn}_9\text{Ga}_1\text{O}/\gamma\text{-Al}_2\text{O}_3$  catalyst after stability test.