CHAPTER V
CONCLUSIONS AND RECOMMENDATIONS

5.1 Conclusions

The hydrogen production from the oxidative steam reforming of methanol (OSRM) was studied over $Au/CeO_2–ZrO_2$ catalysts prepared by a deposition-precipitation (DP) technique. The pure supports (CeO_2 and ZrO_2) and the mixed supports ($CeO_2–ZrO_2$) were prepared by precipitation and co-precipitation techniques, respectively. The effect of the support composition on the catalytic activity by varying atomic ratio of Ce/(Ce+Zr) was investigated. It was found that the 3wt% $Au/Ce_{0.75}Zr_{0.25}O_2$ calcined at 400 °C exhibited the highest catalytic performance when compared with other calcination temperatures. Moreover, the effect of Au content on the catalytic performance was studied and the 3wt% $Au/Ce_{0.75}Zr_{0.25}O_2$ exhibited the highest catalytic activity in the reaction temperature range of 200 °C to 400 °C. At the optimum conditions, the methanol conversion of 91.28% and the hydrogen yield of 61.50% could be obtained. TPR technique showed that the reduction of Au_xO_y species, and CeO_2 surface reduction peak was shifted to lower temperature, resulting in the strong metal-metal and metal-support interactions in the prepared catalysts. The combination of CeO_2 and ZrO_2 can also improve the catalytic activity in the OSRM reaction. Moreover, O_2 pretreatment had no significant effect on the catalytic activity, as supported by XRD technique, there are no phase changing when catalyst are treated with O_2. In addition, at the optimum H_2O/CH_3OH and O_2/CH_3OH molar ratio of the 2/1 and 0.6/1 molar ratio, respectively, exhibited the highest methanol conversion and hydrogen yield in the low reaction temperature range of 200°C to 400°C. It can be ascribed that the OSRM reaction which combined the SRM and POM reactions together gave higher methanol conversion and hydrogen yield. The stability test showed that the 3 wt%$Au/Ce_{0.75}Zr_{0.25}O_2$ catalyst has ability to improve long-term stability when compared with 3 wt%Au/CeO_2 catalyst for OSRM at 350 °C for 12 hours. From TPO result, a small amount of coke formation in the 3 wt%$Au/Ce_{0.75}Zr_{0.25}O_2$ catalyst was obtained when compared with the 3 wt%Au/CeO_2 catalyst.

5.2 Recommendations

The chemical state of gold is very important; therefore, X-ray photoelectron spectroscopy (XPS) is recommended in order to investigate state of gold on the surface of the prepared catalyst.

To achieve higher the hydrogen production and lower CO concentration in the low temperature operating of the OSRM, the bi-metallic containing Au and Cu over CeO_2–ZrO_2 support is recommended, which may be high activity for this reaction.