# CHAPTER VI

# CONCLUSIONS AND RECOMMENDATIONS

This chapter was focused on the conclusion of the experimental results of spherical silica and alumina-silica composites supports on characteristics and catalytic properties of supported cobalt for $CO_2$ hydrogenation reaction which were described in section 6.1. Additionally, recommendations for further study are given in section 6.2.

## 6.1 Conclusions

1. The DTA/TG and XRD patterns indicated that thermal stability of γ-alumina can be enhanced when adding on the spherical silica. At various compositions of alumina-silica, increased amount of alumina exhibited a larger crystalline size of γ-alumina.

2. The alumina distribution on the $Al_2O_3$-$SiO_2$ composite supports prepared by deposition of $Al_2O_3$ particles on the spherical silica particle (SSP) using hydrolysis of aluminium isopropoxide, was uniform.

3. At high calcination temperature, increased amount of alumina obstructed the sintering effect.

4. The presence of alumina in $Al_2O_3$-$SiO_2$ composite supports caused in the decreased reducibilities of cobalt catalysts.

5. The amount of reduced cobalt metal surface atoms slightly decreased with increasing the amount of alumina present in the composite supports.

6. The alumina significantly enhanced the conversion and selectivity to methane of $CO_2$ hydrogenation, indicating the balance among dispersion

of alumina, reducibilities of silica, and pore diameter of alumina-silica composite supported cobalt catalysts.

## 6.2 Recommendations

1. The $CO_2$ hydrogenation performed at higher temperature should be further studied.

2. Besides Co, other metals such as Ni, Fe, Cu and etc should be further investigated with $Al_2O_3$-$SiO_2$ composites on the supports.

3. The Balance among dispersion, reducibilities, and pore diameter of composite supported metal catalysts should be further investigated.