# The synthesize of MeAl – LDH (Me = Co, Ni, Cu) with core-shell structure

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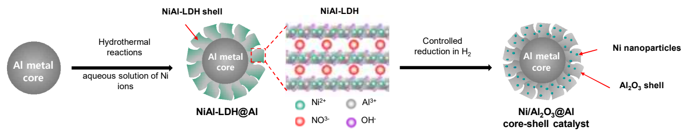
## Introduction

- **Catalysts with metal core** expected to show superior performance in highly exothermic/endothermic reaction such as CO2 methanation
- It is first synthesized catalyst and can be used in **Supercapacitor, catalyst** and others.
- **NiAl-LDH@Al** catalysts perform better than conventional Ni/Al2O3 catalysts at the CO2 methanation reaction

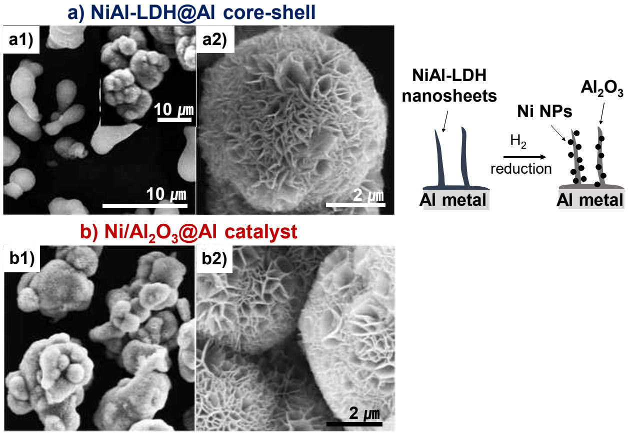
## Experimental

- **MeAl-LDH@Al**
  Prepare Al powder and aqueous solution of Me ions.
  Synthesize MeAl-LDH@Al by using hydrothermal reaction

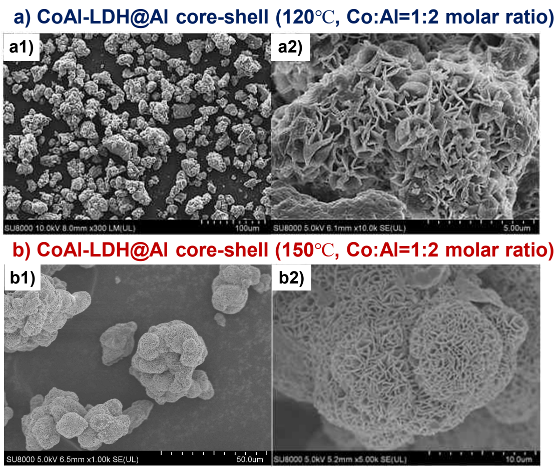



## Results & Discussion

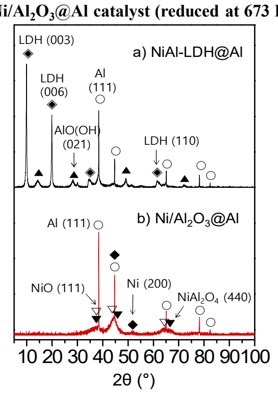
- (a) NiAl-LDH@AL core-shell and (b)Ni/$Al_2O_3$@Al catayst



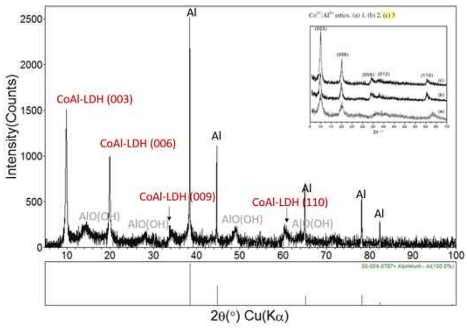

- (a) CoAl-LDH@Al core-shell (120℃) and (b) CoAl-LDH@Al core-shell (150 ℃)




- XRD pattern of the NiAl-LDH@Al core-shell (dried at 393 K) and the Ni/$Al_2O_3$@Al catalyst (reduced at 673 K)




- XRD pattern of the CoAl-LDH@Al core-shell (150℃, Co:Al =1:2 molar ratio)

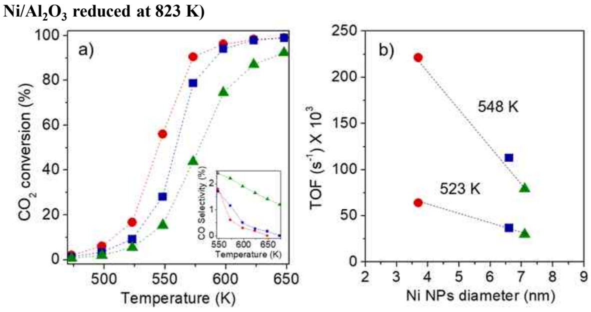



- Properties of the Ni/$Al_2O_3$@Al and the Ni/$Al_2O_3$ catalysts

| Catalyst | Reduction temp. (K) | Ni content [a] (%) | Relative Ni reduction[b] (%) | $H_2$ chemisorption (μmol/g) | Ni dispersion [c] (%) | Average Ni particle size (nm) | | |
|---|---|---|---|---|---|---|---|---|
| | | | | | | $H_2$ chemisorption | XRD | TEM |
| Ni/$Al_2O_3$@Al | 673 | 17.6 | 27 | 127 | 31.4 | 2.0 | 3.7 | 3.9 |
| Ni/$Al_2O_3$@Al | 823 | 17.6 | 85 | 108 | 8.7 | 7.2 | 6.6 | 6.2 |
| Ni/$Al_2O_3$ | 823 | 17.9 | 73 | 78 | 7.0 | 8.9 | 7.1 | 7.4 |

[a] ICP-AES characterization
[b] $H_2$-TPR analysis
[c] calculated from $H_2$-TPR and chemisorption analysis with the reduced Ni net-amount by the reduction treatment

- (a) $CO_2$ conversion and CO selectivity by the $CO_2$ methanation reaction (space velocity = 78,600 ml $h^{-1}$ $g_{cat}^{-1}$, (b) turnover frequency (TOF) on the Ni/$Al_2O_3$@Al core-shell and the conventional Ni/$Al_2O_3$ catalysts (● : Ni/$Al_2O_3$@Al reduced at 673 K, ■ : Ni/$Al_2O_3$@Al reduced at 823 K, ▲: Ni/$Al_2O_3$ reduced at 823 K)




## Conclusions

- A variety of catalysts with aluminum core derived from LDH structure can be prepared by hydrothermal reactions
- Ni catalysts with aluminum core showed good activity, selectivity in CO2 methanation due to high dispersity of nickel and good interaction with the support