

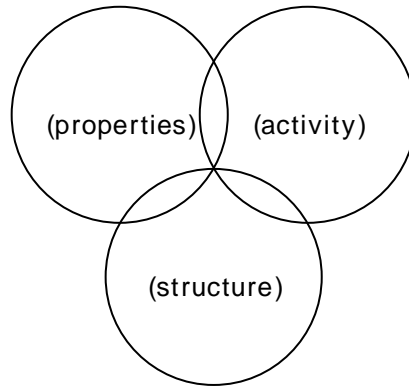
: Charles N. Satterfield, Heterogeneous Catalysis in Industrial Practice," 2nd ed., McGraw -Hill, Inc. (1993).

1 .

1-1

- : ( )
- i. 1835 Berzelius가 catalysis( ) :  
"decomposition of bodies by catalytic force"
- ii. Mitscherlich "contact action"
- i. , , , , , ,  
.  
: , ,
- i. (geometrical theories)
  - 1. .
  - 2. , , :  
Structure sensitivity ( )
- ii. (electronic theories)
  - 1. hole charge carrier  
. (charge -transfer theory )
  - 2. .
- iii.
  - 1. i, ii
  - 2. ,  
.
  - 3. .
- iv.
  - 1. 1918 Sabatier .
  - 2. .
  - 3. 1950  
.
  - 4. .

5. 가



- i.
- ii.

1-2 (Table 1.1 )

1875 Pt

- i.  $SO_2 \rightarrow SO_3$   
(  $V_2O_5 + K_2SO_4 / SiO_2$  )

1903 Ostwald

- i. (NOx ) Pt

1908-1914 (Haber and Bosch)

- i. Fe (  $Al_2O_3, K_2O, CaO, MgO$  )

가

- i. :  $CO + H_2 \rightarrow CH_3OH$  (Cu/ZnO/ $Al_2O_3$ ) (1923 )
- ii. Fischer-Tropsch :  $CO + H_2 \rightarrow$  hydrocarbons (Fe Co )  
(1930 )

i. Methanol  $\rightarrow$  Formaldehyde: Ag  $Fe_2(MoO_4)_3$  (1890 )

ii. Naphthalene  $\rightarrow$  Phthalic anhydride:  $V_2O_5/Al_2O_3$  (1920 )

iii. Benzene  $\rightarrow$  Maleic anhydride:  $V_2O_5 + MoO_3$   $H_3PO_4$  (1928 )  
MA n-butane

iv. Ethylene  $\rightarrow$  Ethylene oxide: Ag/ $\alpha-Al_2O_3$  (1937 , Union Carbide)

- i. Catalytic cracking:  $\gamma$  -  $\text{SiO}_2$  -  $\text{Al}_2\text{O}_3$ ,
  - ii. Reforming (Cyclization of paraffins, dehydrogenation to aromatics): 가  
가 .  $\text{Mo}/\text{Al}_2\text{O}_3$  (1940 , , );  $\text{Pt}/\text{Al}_2\text{O}_3$   
(1950 )
  - iii. , hydrodesulfurization, hydrotreating
- i. DeNOx, DeSOx, CFC, CO<sub>2</sub>, VOC,

1-3

1-3.1

“ 가 ”  
( 가 .)

1-3.2

(activity)

1-3.3

(selectivity) (functionality)

- ( )
  - Cu: , /  
 $\text{C}_2\text{H}_5\text{OH} \rightarrow \text{CH}_3\text{CHO} + \text{H}_2$  ( )
  - $\text{Al}_2\text{O}_3$ : ,  
 $\text{C}_2\text{H}_5\text{OH} \rightarrow \text{C}_2\text{H}_4 + \text{H}_2\text{O}$      $2\text{C}_2\text{H}_5\text{OH} \rightarrow (\text{C}_2\text{H}_4)_2\text{O} + \text{H}_2\text{O}$  ( )
- (functionality)
  - characterization 가 :  
- : 가  
- : 가
  - : Probe reaction
    - alcohol (ethanol or propanol)  
→ olefin:  
→ aldehyde:
    - olefin  
→ (isomerization):  
→ paraffin:
- 2 (bifunctionality)
  - $\text{Pt}/\text{Al}_2\text{O}_3$  n-paraffin iso-paraffin
  - - 1) n-paraffin n-olefin : Pt
    - 2) n-olefin iso-olefin :  $\text{Al}_2\text{O}_3$  ( )

3) iso-olefin iso-paraffin : Pt

□ catalytic reforming, hydrocracking

■ (selectivity) (yield)

□ = ( ) / ( )

= f ( , )

□ = ( ) / ( )

1-3.4 Negative catalyst

■

■

) knocking tetraethyl lead:

(knocking) organic peroxide

1-3.5 Heterohomogeneous catalysis

■ Free radical

■

■

■ ) 가

1-3.6 (sites)

■ Taylor (1948 ): Active site

■ : (coverage) differential heat of adsorption →

■ , 가 ( , ) 가 →

structure insensitive

■

- :  $\sim 10^{15}$  atoms /  $\text{cm}^2$

- :  $10^{11} \sim 10^{13}$  sites /  $\text{cm}^2$

1-3.7 Turnover number

■

■ Turnover frequency: ,

■

- metal :  $\text{H}_2$  CO

- : active

- : Bronsted/Lewis, IR
- : TPD (Temperature Programmed Desorption), IR 가
- NMR

1-3.8

- 가 .  
ex) 가 CoMo/Al<sub>2</sub>O<sub>3</sub> ,

1-3.9

- : IUPAC (Burwell, Advances in Catalysis, 26 (1977) )

- (poisoning)

- ✓
- ✓ , 가
- ✓

- (fouling)

✓

- (sintering)

✓

- 

- ✓
- ✓ ex) Fe<sub>2</sub>(MoO<sub>4</sub>)<sub>3</sub>  
MoO<sub>3</sub>가

- 

- ✓ Ni/Al<sub>2</sub>O<sub>3</sub> , Al<sub>2</sub>O<sub>3</sub> 2가  
Ni Al<sub>2</sub>O<sub>3</sub> . Nickel aluminate가  
( )

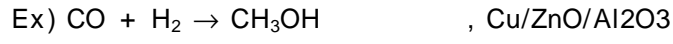
1-4

✓

✓ ,

✓ 가

가



✓

■

■ Reactive distillation membrane reactor

1-4.1

✓

가

✓

✓

Fig. 1.1

1-5

( Table 1.2 )

✓

✓

✓

✓

✓ 8

✓ Pd > Ni > Co > Fe > Cu

가

✓

✓

✓ , (Ru, Rh, Pd, Os, Ir, Pt) Ag, Au

가

✓ Pt, Pd

가

✓

가

✓

✓

. Redox (reduction -oxidation)

- ✓
- ✓ (Cr<sub>2</sub>O<sub>3</sub> )
- ✓
- ✓ , ,
- 가
- ✓
- ✓ W, Co+Mo, Ni+Mo 가 ,
- 가
- ✓

1-6

- ✓ phase
- ✓
- ✓
- ✓ Hydroformylation, carbonylation
- ✓ Carbonylation
- ✓
- ✓
- ✓ hydroformylation
- ✓  $RCH=CH_2 + CO + H_2 \rightarrow RCH_2CH_2CHO$
- ✓
- ✓ Redox system (Wacker )

Pd(II) Cu(II)

