Zeolites

Zeolites and Its Application

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Zeolites - Overview

- Microporous, aluminosilicate minerals comm only used as commercial adsorbents.
- The term zeolite was originally coined in 1756 by Swedish mineralogist Axel Fredrik Cronstedt.
- zeolite, from theGreek ζέω (zeō), meaning "boil" and λίθος (lithos), meaning "stone"
- 1940-1960 Barrer, Synthesis Zeolite

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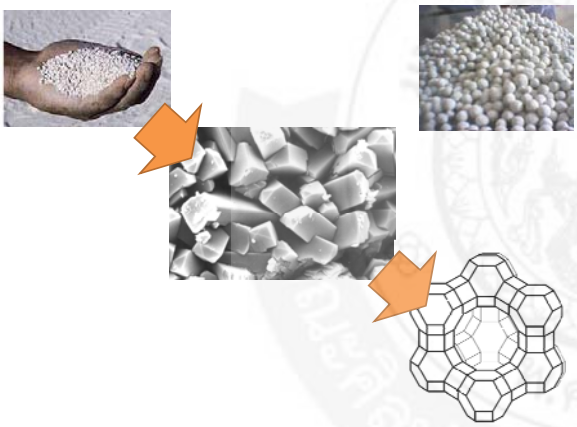
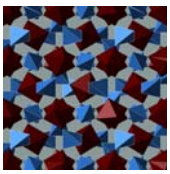
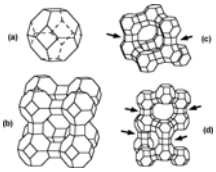


Zeolite - Useful

- Laundry detergents
- Oil refining
- Petrochemical industries
- Adsorbents
- Gas Separations
- Agriculture and horticulture
- Pigments





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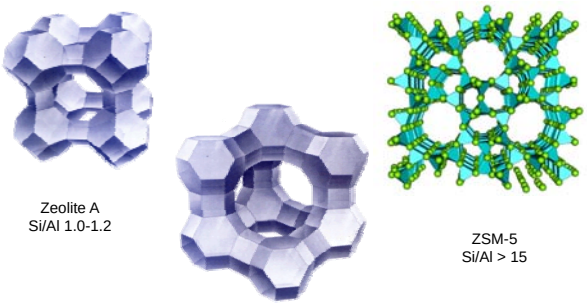

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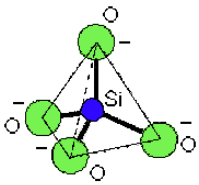
Primary Building Unit

- Tetrahedral of $[SiO_4]^{4-}$ or $[AlO_4]^{5-}$, T-atom



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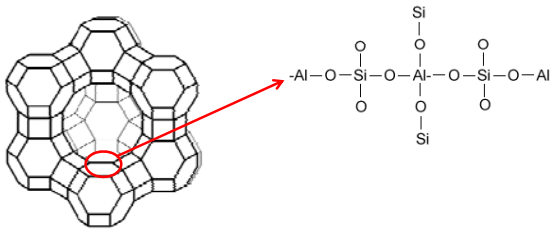
- $[AlO_4]^{5-}$
- **Negative Framework Charge**
- **Charge balancing cation**



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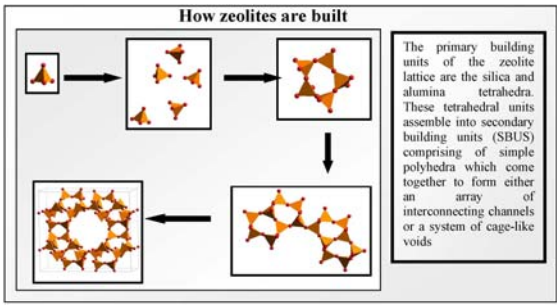

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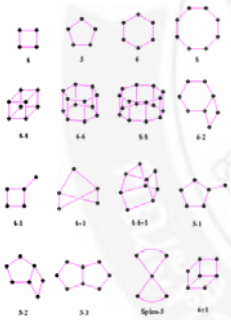
Secondary Building Units, SBUs



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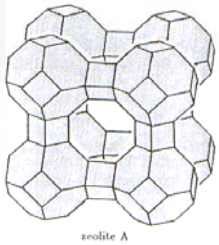
- Si/Al ratio
- Si/Al ≥ 1
- Zeolite A and X (Si/Al ~ 1)
  - Hydrophilic
- Silicalite (Si/Al = ∞)
  - Non-Hydrophilic
  - Hydrocarbon Adsorption



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Zeolite	Structure	Si/Al	SBUs
Zeolite P	GIS	1.5-2	S4R
Cancrinite	CAN	1	S6R
Zeolite L	LTL	3	S6R
Zeolite A	LTA	1	D4R,S8R
Chabasite	CHA	3	D6R, S8R
Faujasite	FAU	1-2.5	S4R, D6R
Thosonsite	THO	1	4-1
ZSM-5	MFI	>15	5-1
Clinophtilolite	HEU	2-2.5	4-4-1

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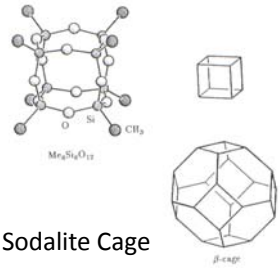
Polyhedra

- Sodalite Cage
- Cancrinite Cage



- Sodalite Cage

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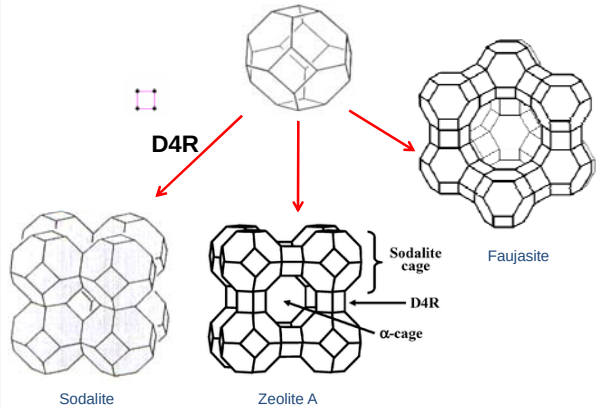

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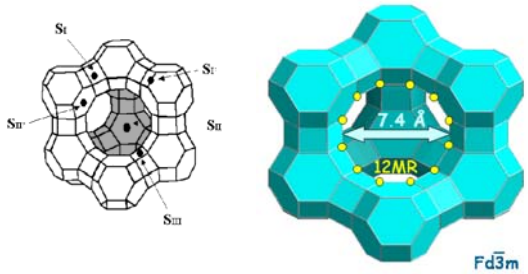
Faujasite



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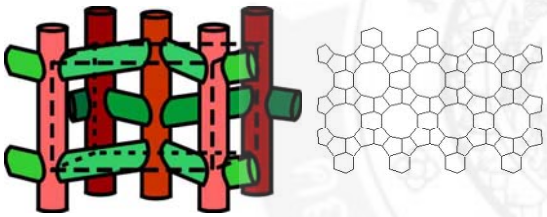
ZSM-5



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The international Zeolite Association (IZA)

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Zeolite

<u>Adsorption of water</u>

- SI/Al ratio
- Pore Structure
- Window size

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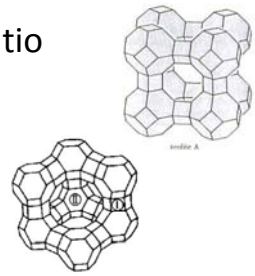
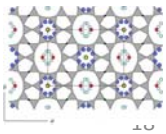
Si/Al ratio



- Row Si/Al ratio
  - Zeolite A, Zeolite X
  - Si/Al ratio = 1
  - Water adsorption
  - Thermal Gravimetric Analysis
- Other
  - Chabasite
  - ZK-5
  - Ferrierite



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Exchanged Cation

- Hardness-Softness
- High Charge Density, Hard cation
- Low Charge Density, Soft cation

$Li^{+} > Na^{+} > K^{+} > Rb^{+} > Cs^{+}$

$Al^{3+} > Mg^{2+} > Na^{+}$

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Zeotype Materials

- Metallosilicates
- Metalloaluminates
- Aluminophosphates
- Siliconaluminophosphates
- Metal-aluminium-phosphorous-oxygen frameworks
- Metal-aluminium-phosphorous-silicon-oxygen frameworks

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Metallosilicates

- Replace Al with B, Ga, Fe (III) or Cr(III)
- Replace Si with Ti, Sn
- Titanosilicate for oxidation
- Ferrosilicate for cracking
- Ga-ZSM-5 for light olefin to aromatic

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Homework

<u>Structure, Pore sizes, Applications</u>

1. Zeolite A (LTA)
2. Ferrierite (FER)
3. Faujasite (FAU)
4. ZSM-5 (MFI)
5. Beta Zeolite (BEA)
6. MCM-22

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