SPEC902a
Matériaux pour la dépollution

4.5 h Courses

Knowledge required : SYNT802 & SYNT902
(Materials Chemistry)

Families of materials for depollution

↳ Different families : carbonaceous materials, (organic)polymers, oxides

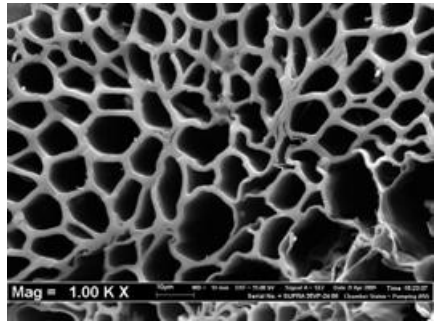
• Carbonaceous materials

→ Activated carbons (powders, pellets, tissues) : C (S, N, P, O…)

→ Functionalised activated carbons

(introduction of specific functional groups on the surface)

→ Activated carbons with supported metals (catalytical properties)



SEM image of an activated carbon

→ Carbons obtained by replication of three-dimensional aluminosilicates (hierarchical porosity)

• Polymer materials

→ Synthetic resins : styrene/divinylbenzene compolymers, polystyrene

+ anionic surface groups : $-SO_3^-$, $-CO_2^-$, $-PO_3^{2-}$,

+ cationic surface groups : $-NR_3^+$, $-NR_2^+$


styrene/divinylbenzene compolymer resin

→ Biopolymers and polymers prepared from natural ressources

(Functionalised cellulose, chitosan, alginate … ⇒ adsorption of heavy metals)

Families of materials for depollution

- **Oxides and related materials**

→ Dense oxides (non porous micro or nanometric Al_2O_3, SiO_2, TiO_2 for photocatalysis)

→ Oxyhydroxides (AlO(OH), FeO(OH) : arsenate capture : AsO_4^{3-})

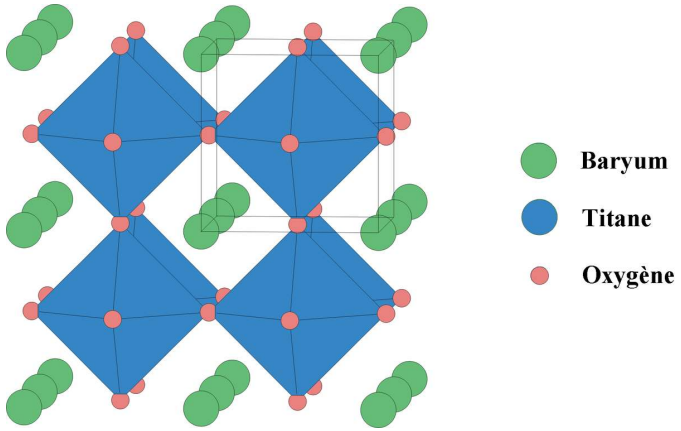
→ Mixte Oxides of perovskite structure ($A^{II}B^{IV}O_3$: catalytic decomposition of NO_x)

→ Clays (Si, Al, O, layered compounds)

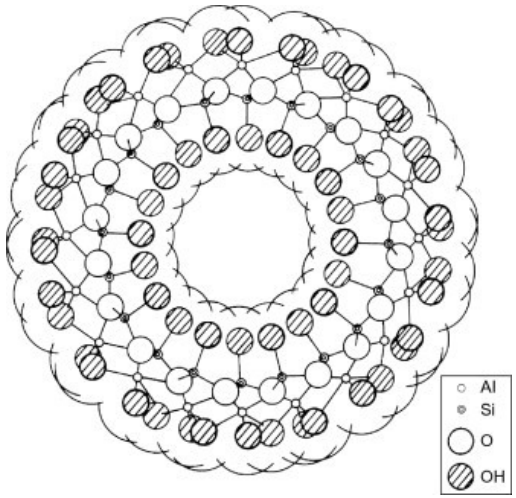
→ Allophanes (Si, Al, O, hollow porous spheres)

→ Zeolites (Si, Al, O, three-dimensional hierarchical porosity, microporous material)

→ Mesoporous solids (SiO_2, Al_2O_3, TiO_2)



$BaTiO_3$ perovskite



Allophane
(imogolite)

Families of materials for depollution

- **Oxides and related materials**

  → Monoliths (dense ceramics with honeycomb porosity: catalytic oxidation of NOx for automotive exhaust gas pollution control)

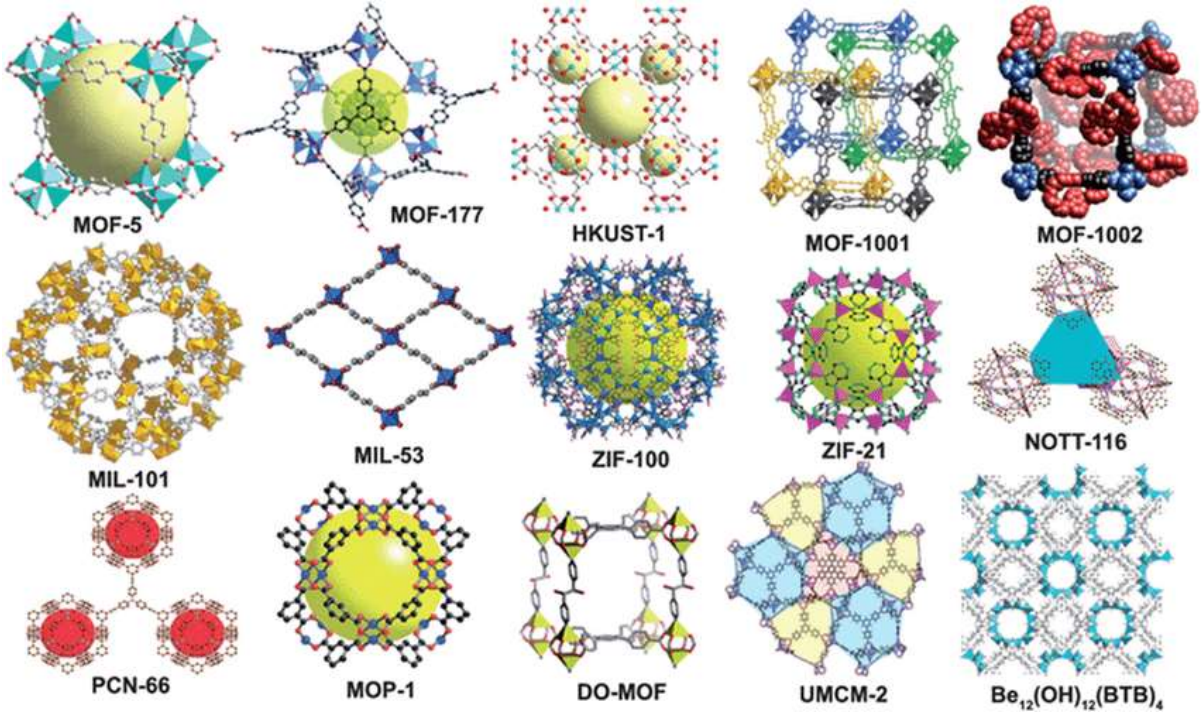
  → Oxides (zeolites, mesoporous) with supported metals (Pt, Pd, Rh, Co) : catalysis

  → Hybrid organic – inorganic materials = grafted oxides

  grafting of molecules possessing specific surface groups ⇒ Combination of organic/inorganic properties

- **Metal Organic Frameworks (MOFs) :**

  crystalline materials with ultrahigh porosity (up to 90% free volume), very high internal surface areas (> 2000 m^2/g)



Required characteristics

- **Stability** in the environment to be depolluted (T, pH, chemical reactivity)
- **Accessible porosity** (open porosity)
- **Matching of porosity** (micro/meso/macro) **to contaminant size**
- **Matching of surface characteristics** (charges, reactive sites dispersion) with targeted pollutants (favorable attractions)
- **Selectivity**
- **Recyclability** (reversibility of process)
- Material **availability**
- Reasonable manufacturing/sourcing **costs**

Objectives

⇨ **Screening of various materials for depollution**

- **Mesoporous solids**
- **Organic/inorganic hybrid materials**
- **Zeolites**
- **Clays, allophanes**

⇒ Main features (cf SYNT802/902)
structure, composition, synthesis, properties….

⇒ Applications for pollution control
study of different cases