Flexibility of atom arrangement
(hot topic: similarities/differences?)

- diamond ($sp^3$)
- fullerene (closed $sp^2$)
- graphite (open $sp^2$)

- nanotube (closed $sp^2$, no pentagons)
(1) Reactions in the Gas Phase

- **Hydrocarbons**
  - Condensation
  - Pyrolysis
  - Polymerization
  - Decomposition (evaporation)

- **Fullerenes**
- **CVD on metallic surfaces**
  - Vapor-grown fibers (filaments)
  - Nanotubes
- **Gas-phase pyrolysis**
  - Carbon black (Soot)
- **CVD on ceramic surfaces**
  - Pyrolytic carbon

Reactions in the Gas Phase:

1. Reactions in the Gas Phase
2. Pyrolytic carbon
3. (2,3)
(2) Reactions in the Solid Phase

Thermosetting Polymers (e.g., coals, PVDC)

Thermal decomposition

- Polymerization
- Decomposition

(1) charring/activation
- Glassy carbon
- Activated carbons (chars)

(1) mostly bottle-neck pores
- Carbon molecular sieves

extrusion (activation)
- Carbon fibers (activated)
(3) Reactions in the Liquid Phase

Thermoplastic Polymers (e.g., coals, PVC)

- Polymerization
- Decomposition

<2000 °C

- Cokes

>2000 °C

- Graphite
- Extrusion (orientation)

>2000 °C

- Carbon fibers (mesophase)

Note: See also Carbon, Vol. 40, 2263-4 (2002).
Pyrolysis

Carbon Precursor (G, L, or S)

Chars, Cokes, Carbon blacks

Graphite