Introduction to Composite Materials

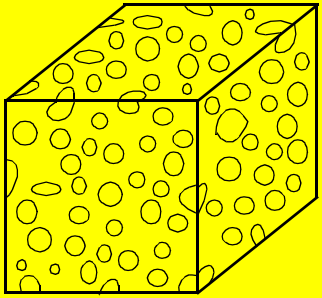
- **com • pos • ite** :

  1 : made up of distinct parts

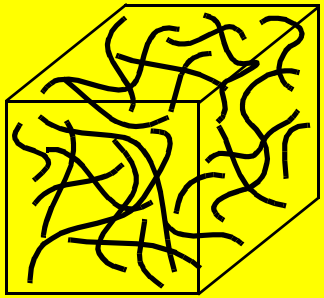
  2 : combining the typical or essential characteristics of individuals making up a group

- Classification based on nature of constituents
  - organic/inorganic
  - metallic/nonmetallic
  - polymer matrix composites: thermoset/thermoplastic

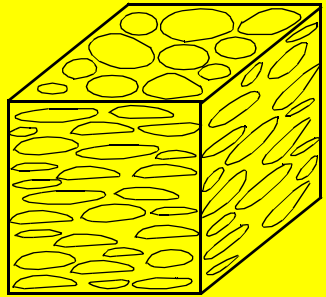
- Composite Materials with Different Forms of Constituents



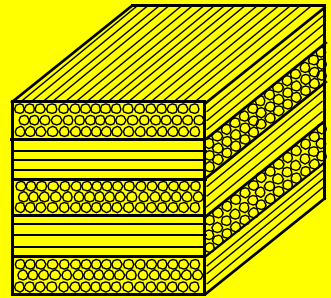
Particulate composite



Fiber reinforced composite

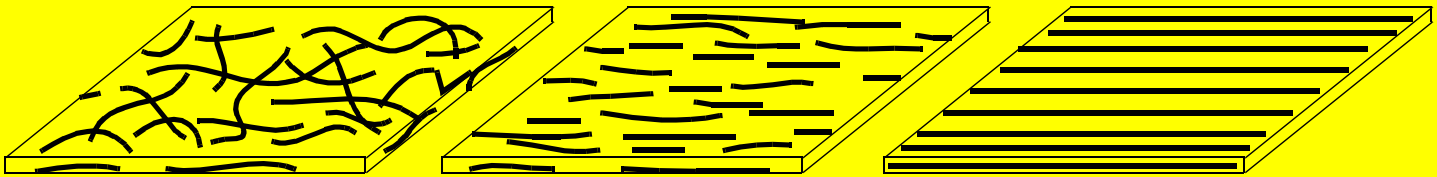


Flake composite

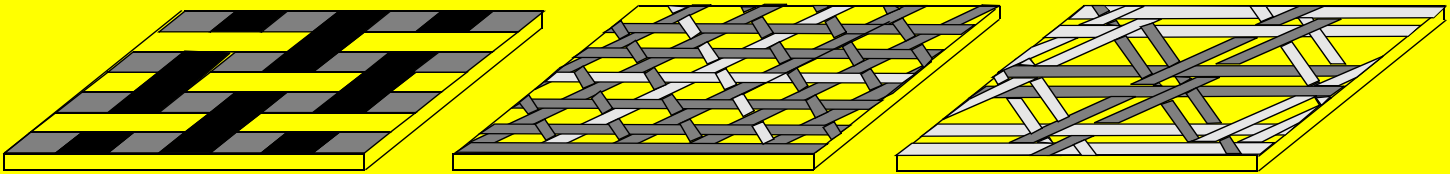


Laminated composite

- Fiber Arrangement Patterns in a Fiber Reinforced Layer

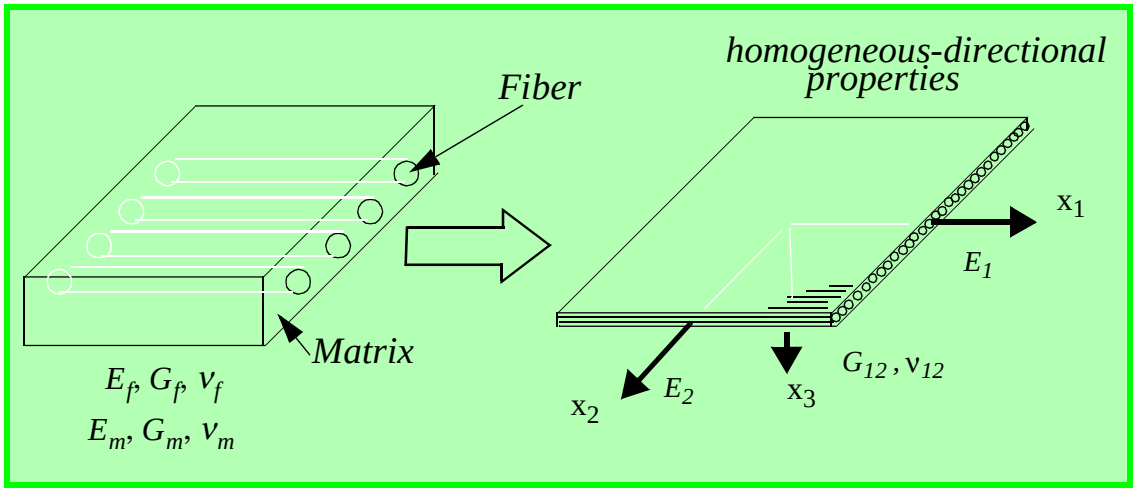


Plain Fibrous Layers



Woven Fabrics

- Elastic Properties from the Properties of Constituents



Fiber and Matrix Volume Fractions

V_f and V_m

$V_f + V_m = 1$

$$E_1 = E_f V_f + E_m V_m \qquad \nu_{12} = \nu_f V_f + \nu_m V_m \qquad \frac{1}{E_2} = \frac{V_f}{E_f} + \frac{V_m}{E_m} \qquad \frac{1}{G_{12}} = \frac{V_f}{G_f} + \frac{V_m}{G_m}$$

• Laminate Stacking Sequence Definition

- $[\theta_1/\theta_2/\theta_3/\ldots/\theta_N]$ total laminate thickness $h = t\,N$
- $[\theta_1/\theta_2/\theta_3/\theta_3/\theta_2/\theta_1]_T = [\theta_1/\theta_2/\theta_3]_s$ symmetric laminate
- $\theta \neq 0°$ or $\theta \neq 90°$ off-axis layers
- Balanced Laminates: $[\theta_1/-\theta_1]$ balanced pair
  - $[\theta_1/-\theta_1/\theta_2/-\theta_2/\theta_3/-\theta_3]$
  - $[\theta_1/90/-\theta_1]$
- $[\theta_1/-\theta_2/\theta_3/-\theta_3/\theta_2/-\theta_1]$ antisymmetric laminates
- $[0/90_2/0_2/90]$ antisymmetric cross-ply laminate