BOMATERIAL
structure

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Type of Biomaterials

- Biomaterials are classified as:
  - **Organic if contain carbon**
  - Inorganic if they do not.
- More specifically biomaterials fall into one of three of materials:
  - Metals (inorganic material)
  - Ceramics(inorganic material)
  - Polymers (organic material)

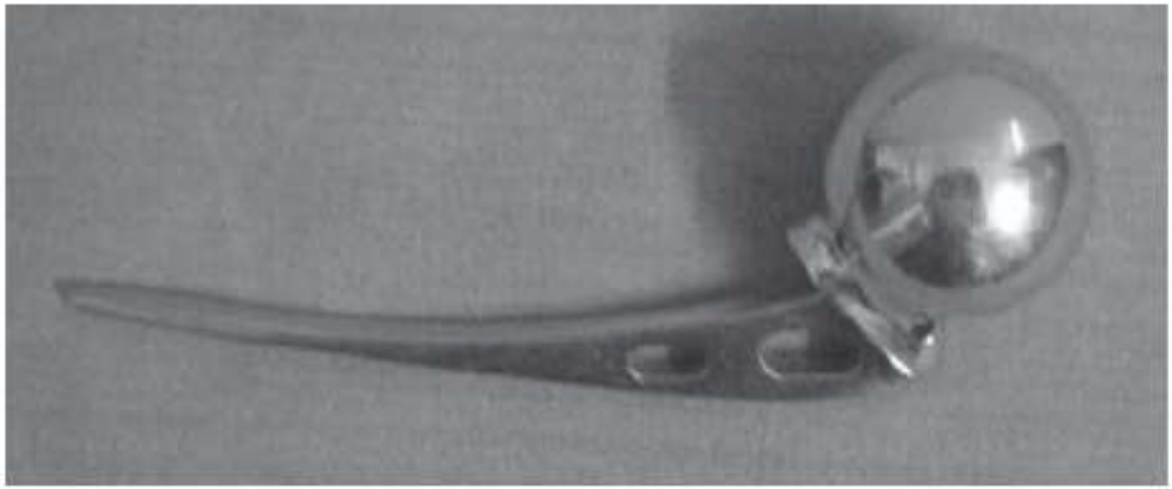

Figure 1.5. Hip screw. (*Courtesy:* Dr. M.K. Agarwal, Nangalia Hospital, Gorakhpur, India, for providing the images of orthopedic implants.)

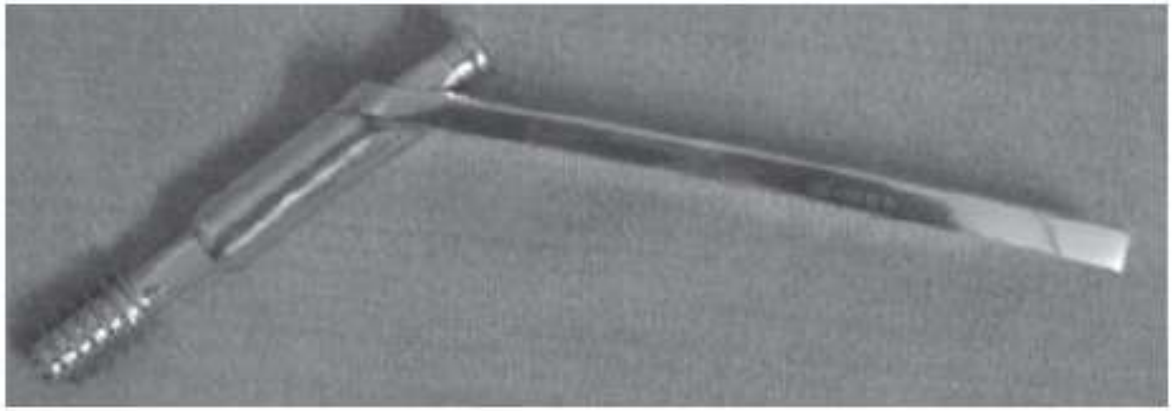

Figure 1.6. Herbert's screw. (*Courtesy:* Dr. M.K. Agarwal, Nangalia Hospital, Gorakhpur, India, for providing the images of orthopedic implants.)

Biomaterial for dental implant

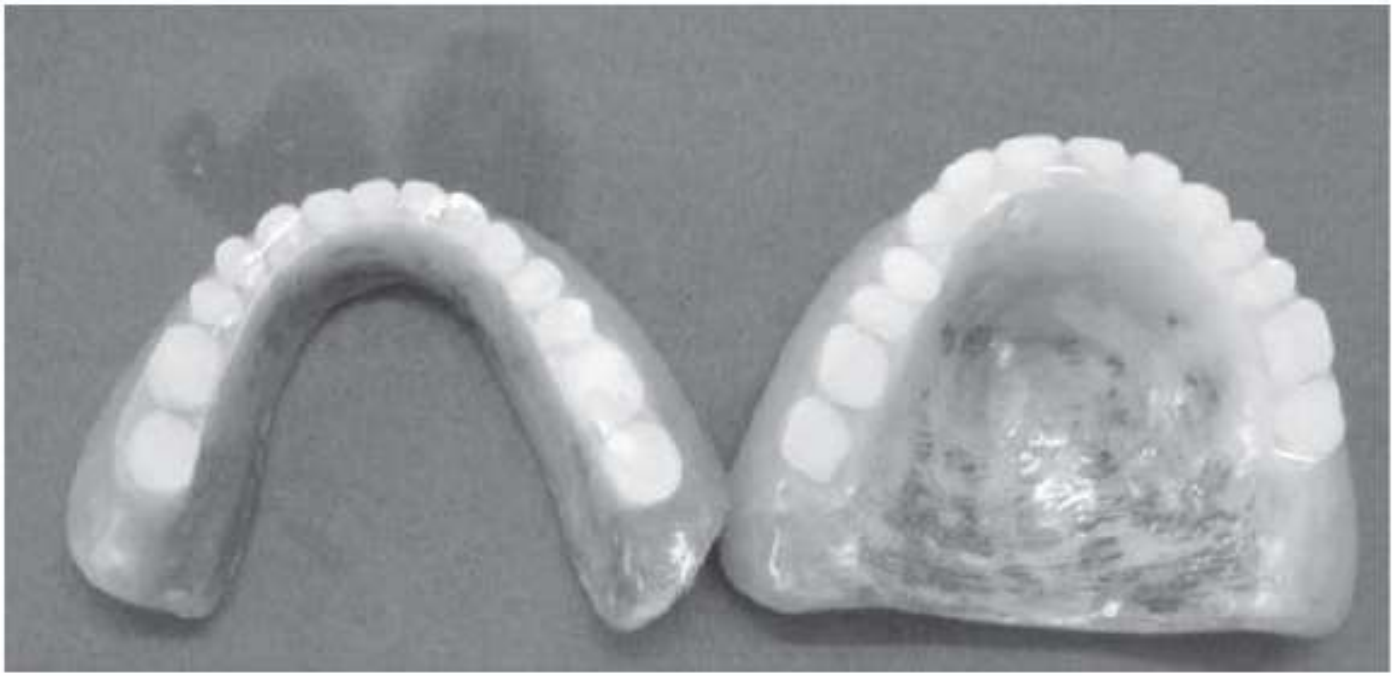

Figure 1.7. Removable complete denture. (*Courtesy:* Dr. Siddharth Tripathi, Dental Clinic, Gorakhpur, India, for providing the images of dental implants.)

Biomaterial for dental implant

Figure 1.8. Complete orthodontic appliance. (*Courtesy:* Dr. Siddharth Tripathi, Dental Clinic, Gorakhpur, India, for providing the images of dental implants.)

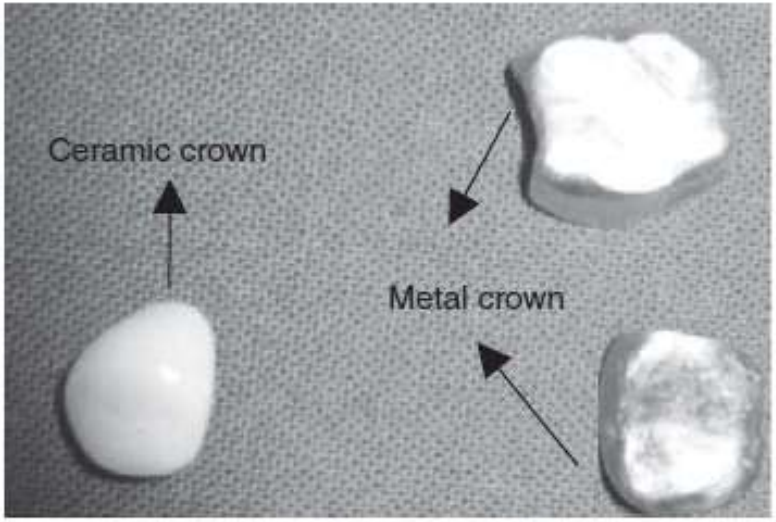

Figure 1.9. Ceramic and metal crown. (*Courtesy:* Dr. Siddharth Tripathi, Dental Clinic, Gorakhpur, India, for providing the images of dental implants.)

Polymer structure

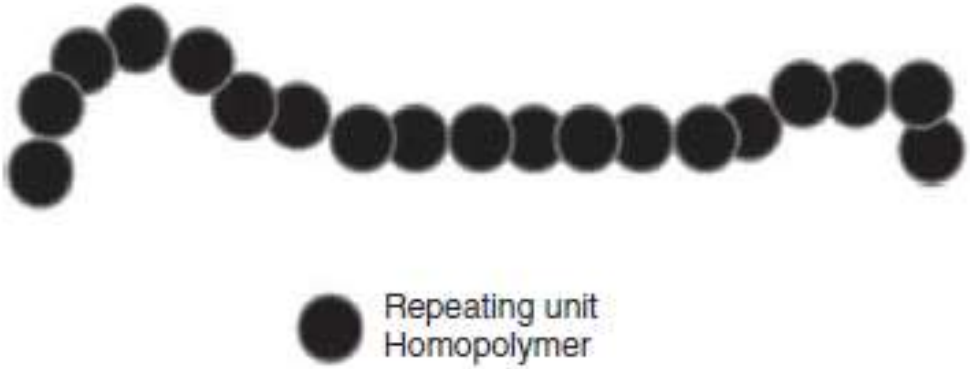

Figure 1.18. Polymeric chain in the homopolymer.

Polymer structure

1. Alternate polymer: The repeat units are alternately arranged

2. Statistical/Random polymer: The repeat units are randomly arranged

3.Graft Polymer: Ther repeat Unit A as the graft and repeat unit B as the main chain

4. Block polymer: The repeat units form clusters

Monomer A

Monomer B

Figure 1.19. Various types of copolymers numbered as 1, 2, 3 and 4 (Alternate, Statistical/Random, Graft, and Block polymer, respectively). The repeat unit comprises monomers A and B.

Biopolymer structure

- Linear
- Branched
- Cyclic
- Cross-linked
- dendritic

Biopolymer structure

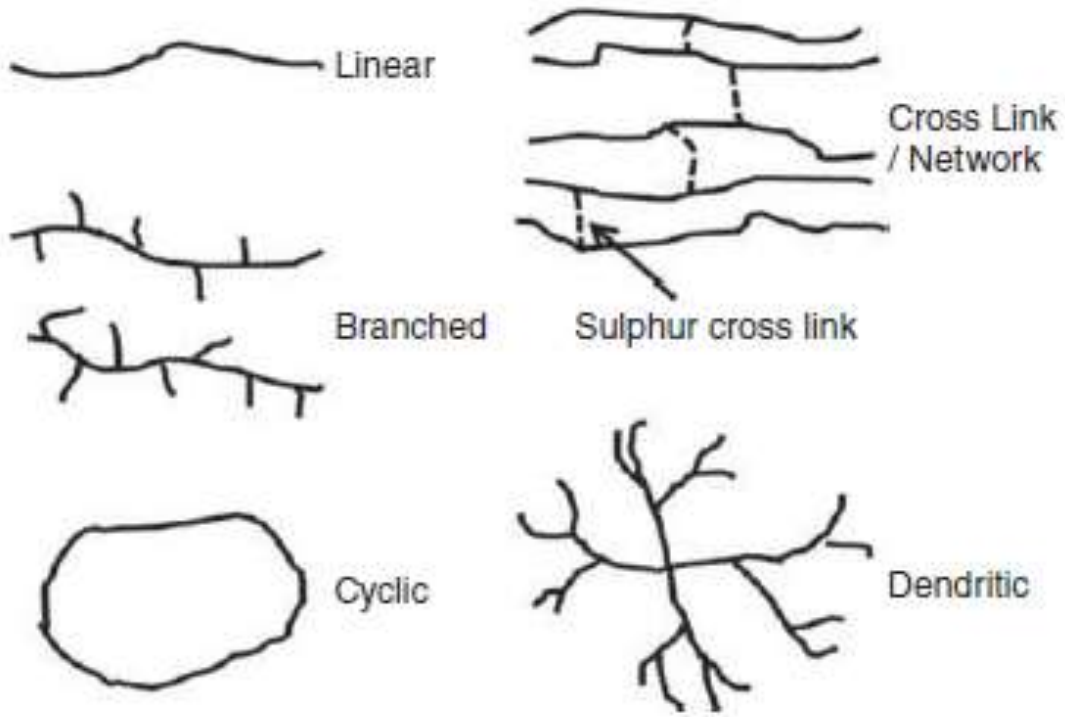

Figure 1.20. Various types of polymeric chains (Linear, Branched, Cyclic, Cross-linked/ Network, and Dendritic).

PMMA

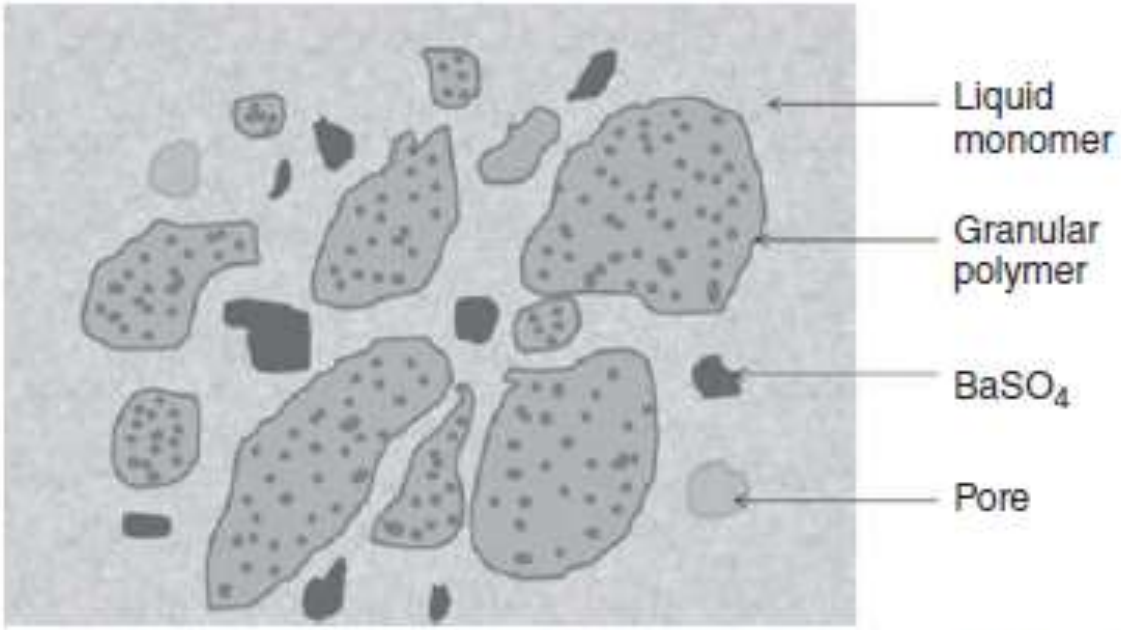

Figure 1.33. Diagrammatic representation of the liquid monomer MMA polymerizing into the solid polymer PMMA [50].

PMMA

- Bone cement
- Strong
- Brittle
- Methyl methacrylate consist of

Silicon

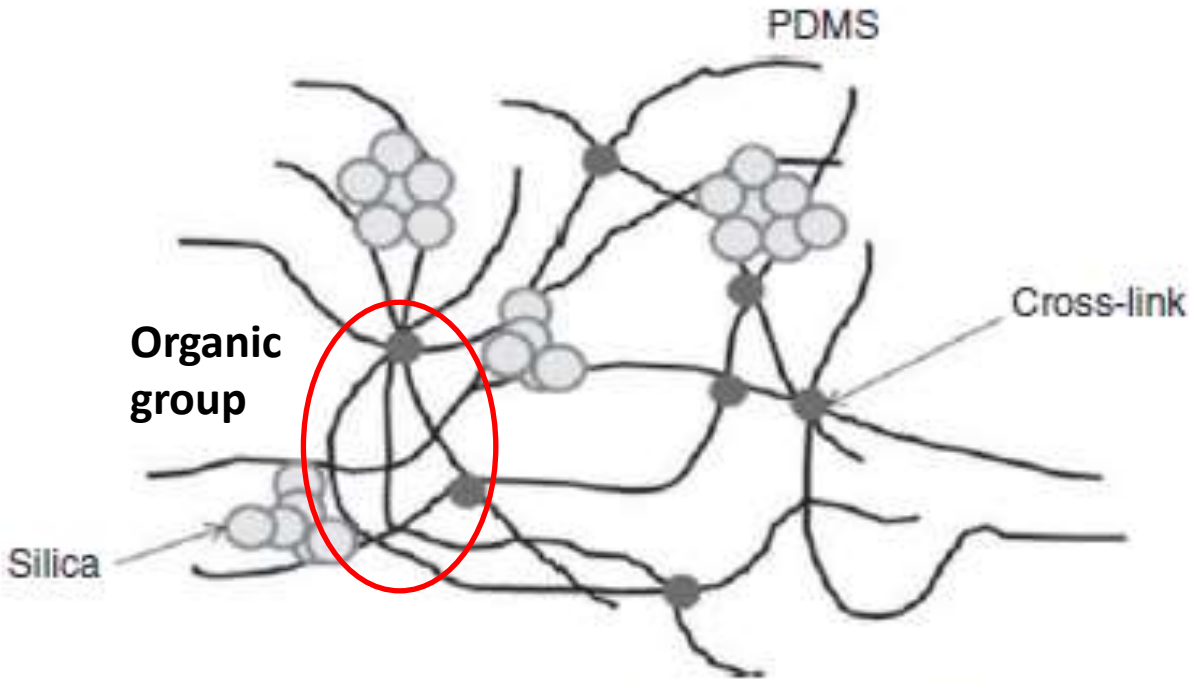

Figure 1.35. Silicone elastomer matrix.

Metal structure

- Metal are mostly used in polycrystal
- Its structure can be analysed by SEM (40000x)
- Its structure can be analysed by TEM (100000x)
- Structure of metal can be single structure or polymorphic
- Metal deposit that was purified from its oxide is called **ores**

Metal crystal structure

FCC

Face centered cubic : ductile

BCC

Body centered cubic

HCP

Hexagonal closed packed

Metal structure

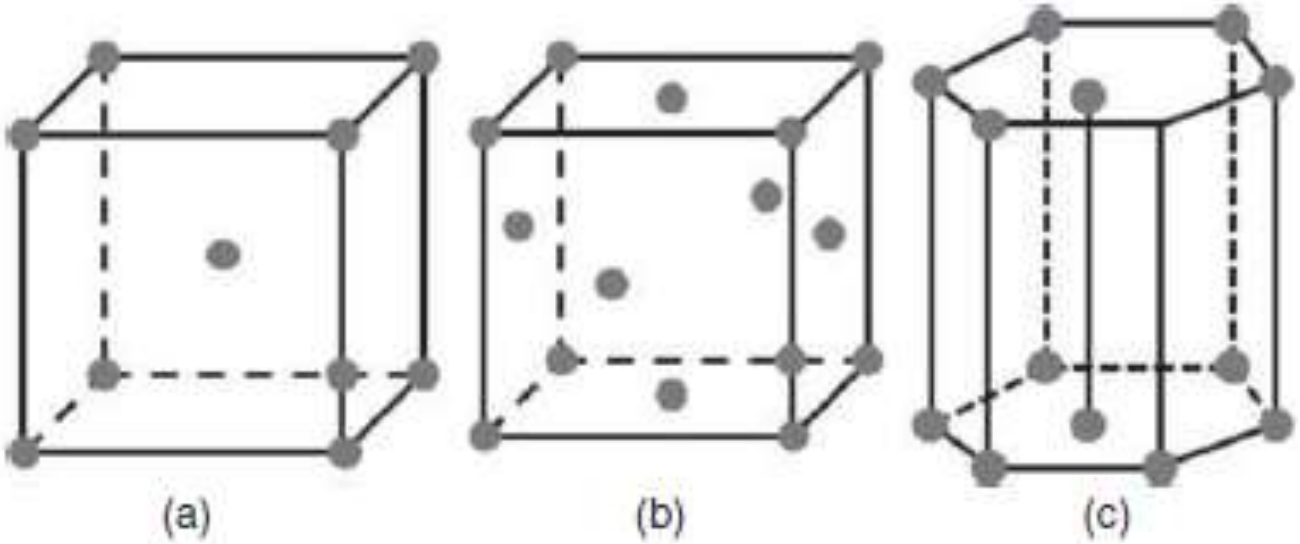

Figure 1.38. Most common crystal structures of metals: (a) BCC, (b) FCC, and (c) HCP.

Structure analysing step

TABLE 1.3. Chemical Composition of Co-Cr Alloys [80, 84, 85]

Co-Cr alloys	ASTM Designation	Element	Composition (wt.%)
Co-Cr-Mo	(F75)	Mn	Max. 1.0
		Si	Max. 1.0
		C	Max. 0.35
		Fe	Max. 0.75
		Ni	Max. 2.5
		Mo	5.0–7.0
		Cr	27.0–30.0
		Co	Approx. 65
Co-Cr-Mo-Ni	(F562)	Mn	Max. 0.15
		Si	Max. 0.15
		C	Max. 0.025
		Fe	Max. 1.0
		Ni	33.0–37.0
		Mo	9.0–10.5
		Cr	19.0–21.0
		Co	Approx. 65

HCP - FCC

- Structure changes by temperature

Titanium exists as hexagonal close packed structure (HCP, α-Ti) until 882 °C and as body-centered cubic structure (BCC, β-Ti) above this temperature [80]. Typically pure

- Structure affect the density

TABLE 1.5. Density of Different Biomaterials [80, 88, 89]

Biomaterial	Density (g/cm^3)
Cortical bone	~2.1
Stainless steel (316 L)	7.9
Cast Co–Cr–Mo alloy	8.3
Co–Cr–Ni–Mo alloy	9.2
Pure Ti	4.5
Ti 6Al4V	4.4
Tantalum	16.6
Magnesium	1.7–2.0

Cracking of ceramic

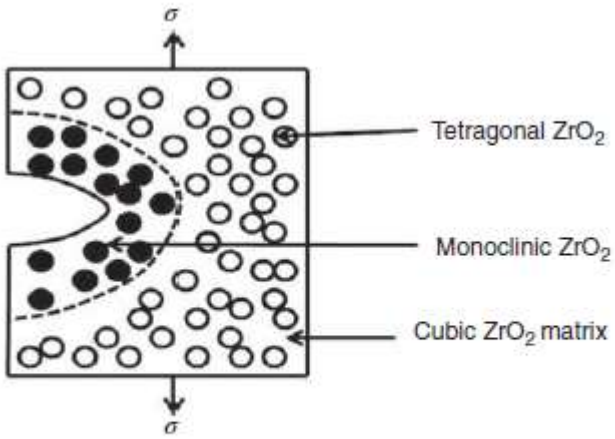

Figure 1.51. Phase transformation or transformation toughening.

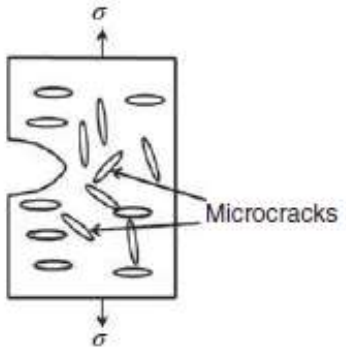

Figure 1.52. Microcracking.

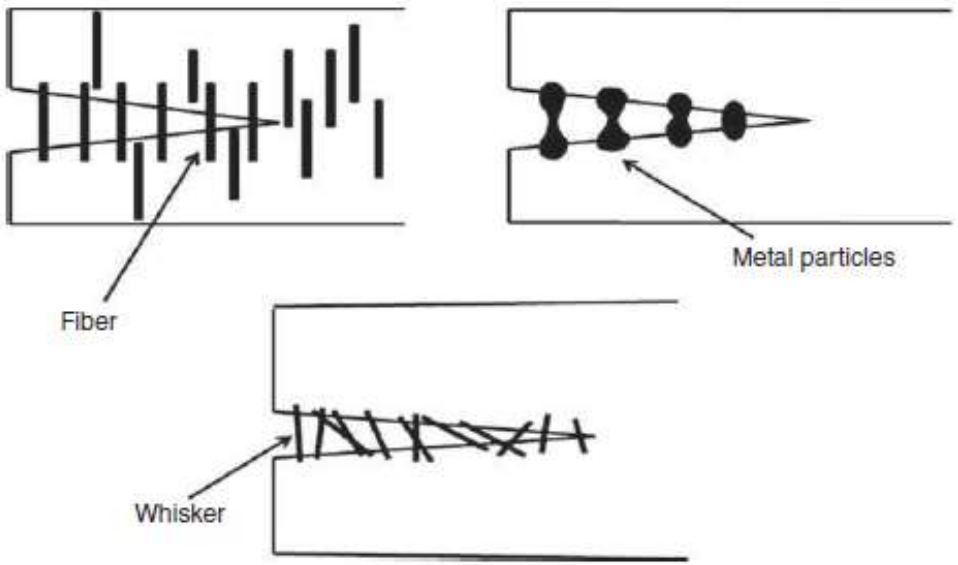

Figure 1.53. Crack bridging methods.

THANKS FOR YOUR ATTENTION

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