

Overview of Dental Materials

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Key concepts, classifications, properties, and clinical considerations

1. Introduction

Dental materials are substances used to restore, replace, or protect teeth and supporting structures. Their selection depends on **biocompatibility, mechanical performance, esthetics, handling, and longevity**.

2. Major Categories

Category	Primary Use	Typical Examples	Core Requirements
Restorative Materials	Fill cavities, rebuild tooth structure	Amalgam, Composite resin, Glass ionomer cement (GIC), Resin-modified GIC, Ceramic inlays/onlays	Strength, wear resistance, marginal seal, esthetics
Prosthetic Materials	Fabricate crowns, bridges, dentures	Metal-ceramics, Full-metal alloys, Zirconia, Lithium disilicate, Acrylic resin (PMMA)	High fracture toughness, dimensional stability, biocompatibility
Endodontic Materials	Seal root canals, obturate, repair perforations	Gutta-percha, Sealers (e.g., epoxy resin, calcium silicate), Mineral trioxide aggregate (MTA)	Sealing ability, radiopacity, biocompatibility
Orthodontic Materials	Move teeth, retain position	Stainless steel brackets, Ni-Ti archwires, Ceramic brackets, Elastics	Elasticity, force control, corrosion resistance
Implant Materials	Replace tooth roots, support prostheses	Titanium (commercially pure, Ti-6Al-4V), Zirconia, Surface-treated alloys	Osseointegration, corrosion resistance, mechanical strength
Preventive Materials	Seal pits/fissures, remineralize	Sealants (resin-based), Fluoride varnish, CPP-ACP	Adhesion, sustained release of ions, low toxicity

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3. Fundamental Properties

3.1 Mechanical

Property	What It Means	Clinical Impact
Compressive strength	Ability to resist crushing forces	Important for posterior restorations
Tensile/ flexural strength	Resistance to pulling or bending	Critical for thin ceramic veneers
Modulus of elasticity	Stiffness of material	Matching tooth modulus reduces stress concentration
Hardness	Resistance to surface indentation	Influences wear of opposing dentition
Fracture toughness	Energy required to propagate a crack	Determines durability of ceramics and alloys

3.2 Physical & Chemical

Property	Relevance
Thermal expansion coefficient (CTE)	Must approximate dentin/enamel to avoid marginal gaps
Water sorption & solubility	Excessive uptake leads to dimensional change & degradation
Radiopacity	Enables radiographic detection of restoration margins
Polymerization shrinkage (for resin-based materials)	Can create marginal gaps; mitigated by incremental placement or low-shrinkage monomers
Adhesion to tooth structure	Determines seal quality; enhanced by bonding agents or chemical coupling

3.3 Biological

- **Biocompatibility** – No cytotoxic, allergenic, or mutagenic effects.

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- **Bioactivity** – Ability to stimulate tissue response (e.g., calcium?silicate cements release calcium ions, promoting dentin bridge formation).
 - **Antimicrobial potential** – Incorporation of agents like silver nanoparticles or quaternary ammonium salts.
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4. Representative Materials & Highlights

4.1 Amalgam

- **Composition:** Silver?tin?copper alloy with mercury.
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