

# Comparisons of Indirect Restorative Dental Materials

TYPES OF INDIRECT RESTORATIVE DENTAL MATERIALS

COMPARATIVE FACTORS	PORCELAIN (GERAMIC)	PORCELAIN (FUSED-TO-METAL)	GOLD ALLOYS (NOBLE)	NICKEL OR COBALT-CHROME (BASE-METAL) ALLOYS
General Description	Glass-like material formed into fillings and crowns using molds of the prepared teeth.	Glass-like material that is "enamelled" onto metal shells. Used for crowns and fixed-bridges.	Mixtures of gold, copper and other metals used mainly for crowns and fixed bridges.	Mixtures of nickel, chromium, copper and fixed bridges; most partial denture frameworks.
Principle Uses	Inlays, veneers, crowns and fixed-bridges.	Crowns and fixed-bridges.	Cast crowns and fixed bridges, inlays, veneers, partial denture frameworks.	Crowns and fixed bridges; most partial denture frameworks.
Resistance to Further Decay	Good. If the restoration fits well.	Good. If the restoration fits well.	Excellent. Does not fracture under stress; does not corrode in the mouth.	Good. A strong material that requires removal of a thin outer layer of the tooth.
Estimated Durability (permanent teeth)	Moderate. Brittle material that may fracture under high biting forces. Not recommended for posterior (molar) teeth.	Very good. Less susceptible to fracture due to the metal substructure.	Excellent. Does not fracture under stress; does not corrode in the mouth.	Good. A strong material that requires removal of a thin outer layer of the tooth.
Relative Amount of Tooth Preserved	Good - Moderate. Little removal of natural tooth is necessary for veneers; more for inlays. Strength is not good in bulk.	Moderate-high. More tooth must be removed to permit the metal to accompany the porcelain.	Good. A strong material that requires removal of a thin outer layer of the tooth.	Good. A strong material that requires removal of a thin outer layer of the tooth.
Resistance to Surface Wear	Resistant to surface wear, but abrasive to opposing teeth.	Resistant to surface wear; permits either metal or porcelain on the biting surface of crowns and bridges.	Similar hardness to natural enamel; does not abrade opposing teeth.	Harder than natural enamel but minimally abrasive to opposing natural teeth; does not fracture in bulk.
Resistance to Fracture	Poor resistance to fractures.	Porcelain may fracture.	Does not fracture in bulk.	Does not fracture in bulk.
Resistance to Leakage	Very good. Can be fabricated for very accurate fit of the margins of the crowns.	Good - Very good depending upon design of the margins of the crowns.	Very good - Excellent. Can be formed with great precision and can be highly adapted to the tooth.	Good-Very good - Sifter than gold; less adaptable, but can be formed with great precision.
Resistance to Occlusal Stresses	Moderate. Brittle material susceptible to fracture under biting forces.	Very good. Metal substructure gives high resistance to fracture.	Excellent.	Excellent.
Toxicity	Excitant. No known adverse effects.	Very good to Excellent. Occasional/rare allergy to metal alloys used.	Excellent. Rare allergy to some alloys.	Good. Nickel allergies are common among women, although rarely manifested in dental restorations.
Allergic or Adverse Reactions	None	Rare. Occasional allergy to metal substructures.	Rare; occasional allergic reactions seen in susceptible individuals.	Occasional; infrequent reactions to nickel.
Susceptibility to Post-Operative Sensitivity	Not material dependent; does not conduct heat and cold well.	Not material dependent; does not conduct heat and cold well.	Conducts heat and cold; may irritate sensitive teeth.	Conducts heat and cold; may irritate sensitive teeth.
Esthetics (Appearance)	Excellent.	Good to Excellent.	Poor - yellow metal	Poor - dark silver metal
Frequency of Repair or Replacement	Varies; depends upon biting forces; fractures of molar teeth are more likely than anterior teeth; porcelain fracture may often be repaired with composite composite resin.	Infrequent; porcelain fracture can often be repaired with composite resin.	Infrequent; replacement is usually due to recurrent decay around margins.	Infrequent; replacement is usually due to recurrent decay around margins.
Relative Costs to Patient	High; requires at least two office visits and laboratory services.	High; requires at least two office visits and laboratory services.	High; requires at least two office visits and laboratory services.	High; requires at least two office visits and laboratory services.
Number of Visits Required	Two - minimum; matching esthetics of teeth may require more visits.	Two - minimum; matching esthetics of teeth may require more visits.	Two - minimum	Two - minimum

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## The Dental Board of California Dental Materials Fact Sheet

Adopted by the Board on October 17, 2001

As required by Chapter 801, Statutes of 1992, the Dental Board of California has prepared this fact sheet to summarize information on the most frequently used restorative dental materials. Information on this fact sheet is intended to encourage discussion between the patient and dentist regarding the selection of dental materials best suited for the patient's dental needs. It is not intended to be a complete guide to dental materials science.

The most frequently used materials in restorative dentistry are amalgam, composite resin, glass ionomer cement, resin-bondomer cement, porcelain (ceramic), porcelain (fused-to-metal), gold alloys (noble) and nickel or cobalt-chrome (base-metal) alloys. Each material has its own advantages and disadvantages, benefits and risks. These and other relevant factors are compared in the attached matrix titled "Comparisons of Restorative Dental Materials." A Glossary of Terms is also attached to assist the reader in understanding the terms used.

The statements made are supported by relevant, credible dental research published mainly between 1993 - 2001. In some cases, where contemporary research is sparse, we have indicated our best perceptions based upon information that predates 1993.

The reader should be aware that the outcome of dental treatment or durability of a restoration is not solely a function of the material from which the restoration was made. The durability of any restoration is influenced by the dentist's technique when placing the restoration, the ancillary materials used in the procedure, and the patient's cooperation during the procedure. Following restoration of the teeth, the longevity of the restoration will be strongly influenced by the patient's compliance with dental hygiene and home care, their diet and chewing habits.

Both the public and the dental profession are concerned about the safety of dental treatment and any potential health risks that might be associated with the materials used to restore the teeth. All materials commonly used (and listed in this fact sheet) have been shown -- through laboratory and clinical research, as well as through extensive clinical use -- to be safe and effective for the general population. The presence of these materials in the teeth does not cause adverse health problems for the majority of the population. There exist a diversity of various scientific opinions regarding the safety of mercury dental amalgams. The research literature in peer-reviewed scientific journals suggests that otherwise healthy women, children and diabetics are not at increased risk for exposure to mercury from dental amalgams. Although there are various opinions with regard to mercury risk in pregnancy, diabetes, and children, these opinions are not scientifically conclusive and therefore the dentist may want to discuss these opinions with their patients. There is no research evidence that suggests pregnant women, diabetics and children are at increased health risk from dental amalgam fillings in their mouth. A recent study reported in the JADA factors in a reduced tolerance (1/50<sup>th</sup> of the WHO safe limit) for exposure in calculating the amount of mercury that might be taken in from dental fillings. This level falls below the established safe limits for exposure to a low concentration of mercury or any other released component from a dental restorative material. Thus, while these sub-populations may be perceived to be at increased health risk from exposure to dental restorative materials, the scientific evidence does not support that claim. However, there are individuals who may be susceptible to sensitivity, allergic or adverse reactions to selected materials. As with all dental materials, the risks and benefits should be discussed with the patient, especially with those in susceptible populations.



## Comparisons of Direct Restorative Dental Materials

There are differences between dental materials and the individual elements or components that compose these materials. For example, dental amalgam filling material is composed mainly of mercury (43-54%) and varying percentages of silver, tin, and copper (46-57%). It should be noted that elemental mercury is listed on the Proposition 65 list of known toxins and carcinogens. Like all materials in our environment, each of these elements by themselves is toxic at some level of concentration if they are taken into the body. When they are mixed together, they react chemically to form a crystalline metal alloy. Small amounts of free mercury may be released from amalgam fillings over time and can be detected in bodily fluids and expired air. The important question is whether any free mercury is present in sufficient levels to pose a health risk. Toxicity of any substance is related to dose, and doses of mercury or any other element that may be released from dental amalgam fillings falls far below the established safe levels as stated in the 1999 US Health and Human Services Toxicological Profile for Mercury Update.

All dental restorative materials (as well as all materials that we come in contact with in our daily life) have the potential to elicit allergic reactions in hypersensitive individuals.<sup>1</sup> These must be assessed on a case-by-case basis, and susceptible individuals should avoid contact with allergenic materials. Documented reports of allergic reactions to dental amalgam exist (usually manifested by transient skin rashes in individuals who have come into contact with the material), but they are atypical. Documented reports of toxicity to dental amalgam exist, but they are rare. There have been anecdotal reports of toxicity to dental amalgam and as with all dental material risks and benefits of dental amalgam should be discussed with the patient, especially with those in susceptible populations.

Composite resins are the preferred alternative to amalgam in many cases. They have a long history of biocompatibility and safety. Composite resins are composed of a variety of complex inorganic and organic compounds, any of which might provoke allergic response in susceptible individuals. Reports of such sensitivity are atypical. However, there are individuals who may be susceptible to sensitivity, allergic or adverse reactions to composite resin restorations. The risks and benefits of all dental materials should be discussed with the patient, especially with those in susceptible populations.

Other dental materials that have elicited significant concern among dentists are nickel-chromium-beryllium alloys used predominantly for crowns and bridges. Approximately 10% of the female population are alleged to be allergic to nickel.<sup>2</sup> The incidence of allergic response to dental restorations made from nickel alloys is surprisingly rare. However, when a patient has a positive history of confirmed nickel allergy, or when such hypersensitivity to dental restorations is suspected, alternative metal alloys may be used. Discussion with the patient of the risks and benefits of these materials is indicated.

TYPES OF DIRECT RESTORATIVE DENTAL MATERIALS				
COMPARATIVE FACTORS	AMALGAM	COMPOSITE RESIN (DIRECT AND INDIRECT RESTORATIONS)	GLASS IONOMER CEMENT	RESIN/IONOMER CEMENT
General Description	Self-hardening mixture of liquid mercury and silver-tin alloy fillings, sometimes for replacing portions of broken teeth.	Mixture of powdered glass and hardened by exposure to blue light. Fillings, inlays, veneers, partial and complete crowns, sometimes for replacing portions of broken teeth.	Self-hardening mixture of glass and organic acid. Small fillings, cementing metal & porcelain/metal crowns, inlays, temporary restorations.	Mixture of denture base polymer and organic acid; self-hardening by exposure to blue light. Small fillings, cementing metal & porcelain/metal crowns, and liners.
Principle Uses	High, self-sealing characteristic helps resist recurrent decay, but recurrent decay around amalgam is difficult to detect in its early stages. Curable	Moderate; recurrent decay is easily detected in early stages.	Low-Moderate; some resistance to decay may be imparted through fluoride release.	Low-Moderate; some resistance to decay may be imparted through fluoride release.
Resistance to Further Decay	Fair. Requires removal of healthy tooth to be mechanically retained. No adhesive bond of amalgam to the tooth.	Excellent; bonds adhesively to healthy enamel and dentin.	Excellent; bonds adhesively to healthy enamel and dentin.	Excellent; bonds adhesively to healthy enamel and dentin.
Estimated Durability (agement teeth)	Low Similar to dental enamel; brittle metal.	May wear slightly faster than dental enamel.	Poor in stress-bearing applications. Fair in non-stress-bearing applications.	Poor in stress-bearing applications. Good in non-stress-bearing applications.
Resistance to Surface Wear	Amalgam may fracture under stress; tooth around filling may fracture before the amalgam does.	Good resistance to fracture.	Good resistance to fracture but not recommended for stress-bearing restorations.	Good; adhesive bonds to resin enamel; dentin. Post-injection expansion may help seal the margins.
Resistance to Fracture	Good; self-sealing by surface corrosion; margins may chip over time.	Does not corrode.	Moderate; tends to crack over time.	Good; adhesive bonds to resin enamel; dentin. Post-injection expansion may help seal the margins.
Resistance to Occlusal Stress	High; but lack of adhesion may weaken the remaining tooth.	Good to Excellent depending upon product used.	Poor; not recommended for stress-bearing restorations.	Moderate; not recommended to restore biting surfaces of adult teeth restorations.
Toxicity	Generally safe; occasional allergic reactions to metal components. However amalgam contains mercury, which may be an elemental form of toxic (as such is listed on prop. 65)	Concerns about trace chemical release are not supported by research studies. Safe; no known toxicity documented. Contains some components listed on prop. 65.	No known incompatibilities. Safe; no known toxicity documented.	No known incompatibilities. Safe; no known toxicity documented.
Allergic or Adverse Reactions	Rare; recommend that dentist evaluate patient to rule out metal allergies.	No documentation for allergic reactions was found.	No documentation for allergic reactions was found. Progressive roughening of the surface may predispose to plaque accumulation and periodontal disease.	No known documented allergic reactions; Since may roughen slightly over time; predisposing to plaque accumulation and periodontal disease if the material contacts the gingival tissue.
Susceptibility to Post-Operative Sensitivity	Minimal. High thermal conductivity may promote temporary sensitivity to hot and cold. Contact with other metals may cause occasional and transient galvanic response.	Moderate; Material is sensitive to dentist's technique. Material shrinks slightly when hardened, and a poor seal may lead to bacterial leakage, recurrent decay and tooth hypersensitivity.	Low; material seals well and does not irritate pulp.	Low; material seals well and does not irritate pulp.
Esthetics (Appearance)	Very poor. Not tooth-colored; initially silver-gray; gets darker. May stain teeth, dark brown or black over time.	Excellent; often indistinguishable from natural tooth.	Good; tooth-colored; varies in translucency.	Very good; more translucency than glass ionomer.
Frequency of Repair or Replacement	Low; replacement is usually due to fracture of the filling or the surrounding tooth.	Low/Moderate; durable material hardens rapidly; some composite materials show more rapid wear than amalgam. Replacement is usually due to marginal leakage.	Moderate; Slowly dissolves in mouth; easily dislodged.	Moderate; more resistant to dissolving than glass ionomer, but less than composite resin.
Relative Costs to Patient	Low; relatively inexpensive; actual cost of fillings depends upon their size.	Moderate; higher cost of fillings depends upon their size; veneers & crowns cost more.	Moderate; similar to composite resin (not used for veneers and crowns).	Moderate; similar to composite resin (not used for veneers and crowns).
Number of Visits Required	Single visit (polishing may require a second visit)	Single visit for fillings; 2+ visits for indirect inlays, veneers and crowns.	Single visit.	Single visit.

<sup>1</sup> Dental Amalgam: A scientific review and recommended public health service strategy for research, education and regulation. Dept. of Health and Human Services, Public Health Service, January 1993.

<sup>2</sup> Merck Index 1983, Tenth Edition, M Narsha Windholz & (ed).