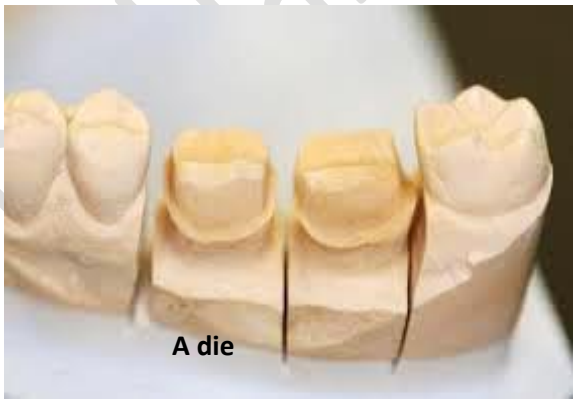
Impression Materials

- Impression materials are used to make an accurate replica or mold of the hard and soft oral tissues.
- The area involved may vary from a single tooth to the whole dentition, or an impression may be made of an edentulous mouth.
- The impression is a negative reproduction of the tissues, and by filling the impression with dental stone or other model material, a positive cast is made that can be removed after the model material has set.
- Casts of the mouth are used to evaluate the dentition when orthodontic, occlusal, or other problems are involved, and in the laboratory fabrication of restorations and prostheses.
- Usually the impression material is carried to the mouth in an unset (flowable) condition in a tray and applied to the area under treatment. When the impression material has set, it is removed from the mouth with the tray. The cast is made by filling the impression with dental stone or other model material or by scanning the impression and printing a plastic model from the digital impression.
- The accuracy, detail, and quality of this final replica are of greatest importance.
- When the positive reproduction takes the form of the tissues of the upper or lower jaw and serves for the construction of dentures, crowns, fixed dental prostheses, and other restorations, it is described as a cast.
- The positive reproduction of the form of a prepared tooth constitutes a die for the preparation of inlays or fixed dental prostheses.
- When a positive likeness of the arch or certain teeth is reproduced for orthodontic treatment, it is sometimes described as a model, although cast is the more proper term.
- Sometimes impression materials are used to duplicate a cast or model that has been formed when more than one positive reproduction is required. Such impression materials are referred to as duplicating materials.

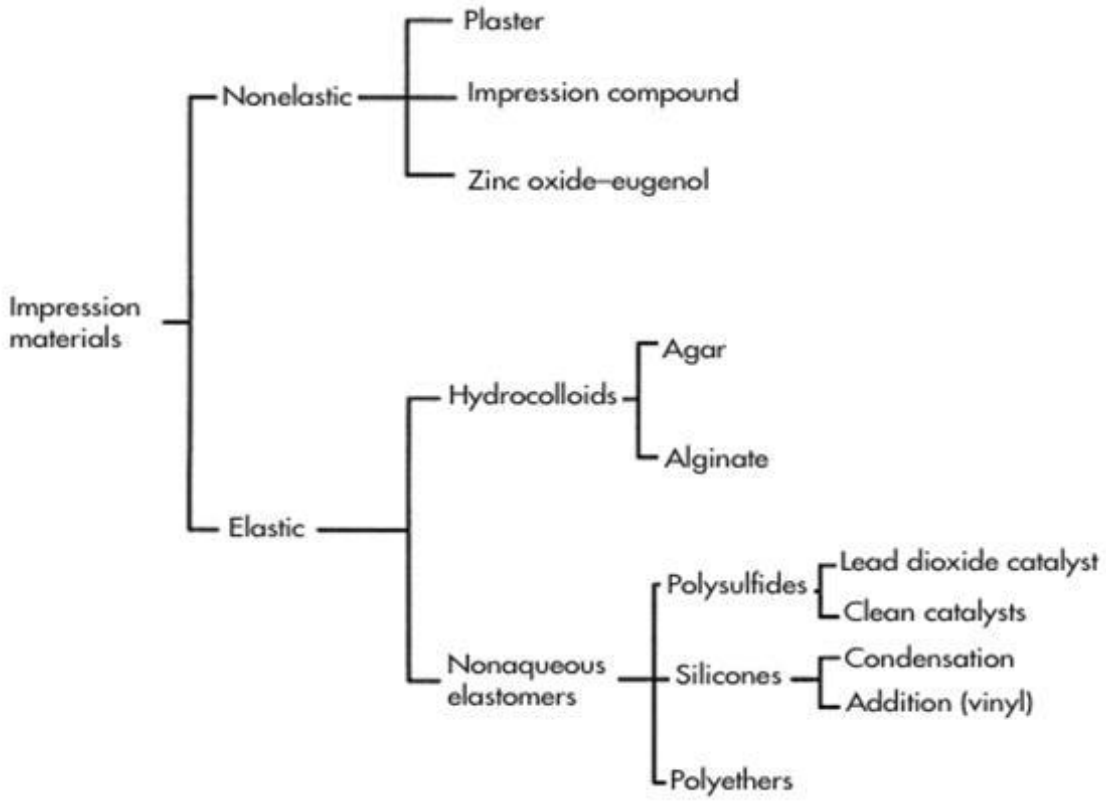


A die

The ideal properties of an impression material:

1. A pleasant odor, taste, and acceptable color.
2. Absence of toxic or irritant constituents.
3. Adequate shelf life for requirements of storage and distribution.
4. Sufficiently fluid to adapt to the oral tissues.
5. Viscous enough to be contained in a tray.
6. Able to transform (set) into a rubbery or rigid solid in the mouth in a reasonable time (<7 minutes).
7. Resistant to distortion or tearing when removed from the mouth.
8. Dimensionally stable long enough to allow one or more casts to be poured.
9. Biocompatible.
10. Cost-effective in terms of the required processing time and the expense of the materials and associated processing equipment.

Classification of Impression Materials:



A/ Elastic Impression Materials:

The term elastic in impression materials means that the material can be flexed easily without fracture and returns to its original form when unstressed.
The ability of elastic impression materials to rebound after removal from the mouth makes them suitable for reproducing both the hard and soft structures of the mouth, including the undercuts and interproximal spaces.
Types of elastic impression materials:

1. Hydrocolloids.
2. Elastomers.

Hydrocolloids

A hydrocolloid is a substance that is microscopically dispersed uniformly throughout water. The sizes of the colloid particles range from 1 to 200 nm. In hydrocolloids the transformation from a flowable state to a solid elastomeric state is called the sol–gel transformation. Hydrocolloids include alginate (irreversible) and agar (reversible).

Alginate (Irreversible Hydrocolloid)

Uses:

They are the most widely used impression materials in dentistry.

1. They are used for making impressions for removable partial dentures with clasps.
2. Preliminary impressions for complete dentures.
3. For making orthodontic and study casts.

Composition:

Alginates are supplied as a powder containing :

1. Potassium and sodium salts of alginic acid (sodium or potassium alginate) (12% to 15%) (To dissolve in water and react with calcium ions).
   The alginic acid is extracted from brown seaweed.
2. calcium sulfate dihydrate (8% to 12%) as reactants (To react with potassium alginate to form an insoluble calcium alginate gel).
3. sodium phosphate (2%) as a retarder. To react preferentially with calcium ions to provide working time before gelation. The sodium phosphate content is adjusted by the manufacturer to produce either regular- or fast-set alginates.
4. a reinforcing filler (70%), such as diatomaceous earth or fine siliceous particles (a respiratory irritant), to control the consistency of the mixed alginate the stiffness of the set gel.
5. Potassium sulfate or alkali zinc fluorides (~10%) to provide good surfaces on gypsum dies.
6. Coloring and flavoring agents (traces) for esthetics.
7. To avoid the inhalation of alginate dust, some materials have been introduced in a dustless version in which the powder is coated with a glycol.
8. Some products contain a chemical disinfectant in the alginate powder to control infection.
   Two examples of these disinfectants are quaternary ammonium chloride and chlorhexidine acetate. When the quaternary ammonium compound is used, the detail reproduction and gypsum

compatibility of the alginate improve. However, the impressions made from these materials should still be disinfected on removal from the mouth.

9. pH indicators that change color when setting has occurred.

Chemistry:

The powder is mixed with water to obtain a paste. Two main reactions occur when the powder reacts with water during setting:

First, the sodium phosphate reacts with the calcium sulfate to provide adequate working time.

Second, after the sodium phosphate has reacted, the remaining calcium sulfate reacts with the sodium alginate to form an insoluble calcium alginate, which forms a gel with the water (Gelation Process :The typical sol–gel reaction can be described simply as a reaction of soluble alginate with calcium ions from calcium sulfate and the formation of an insoluble calcium alginate).

The material cannot be re-liquefied to a sol. These hydrocolloids are called irreversible.

Proportioning and Mixing:

The proportioning of the powder and water before mixing is critical to obtaining consistent results. Changes in the water-to-powder (W/P) ratio will alter the consistency and setting times of the mixed material and also the strength and quality of the impression. Usually the manufacturers provide suitable containers for proportioning the powder and water by volume, and these are sufficiently accurate for clinical use. The mixing time for regular alginate is 1 minute; the time should be carefully measured, because both undermixing and overmixing are detrimental to the strength of the set impression. Fast-set alginates should be mixed with water for 45 seconds. The measured powder is added slowly to the premeasured water that has already been poured into a clean rubber bowl. The powder is incorporated into the water by carefully mixing with a metal or plastic spatula that is flexible to adapt well to the wall of the mixing bowl. If the powder is placed in the mixing bowl first, penetration of the water to the bottom of the bowl is inhibited, and a longer mixing time may be required to ensure a homogeneous mix. Care should be taken to avoid incorporating excessive air into the mix. A vigorous figure-eight stropping motion is best, with the mix being wiped or stropped against the side of the rubber-mixing bowl to express air bubbles. All the powder must be incorporated thoroughly in the water. Adequate spatulation gives a smooth, creamy mix with a minimum of voids. Mechanical mixing devices are also available.

Types:

1. The fast-set alginate.
2. The regular-set alginate.

Properties:

- Working time

The fast-set materials have working times of 1.25 to 2 minutes.

The regular-set materials have working times of 3 to 4.5 minutes.

- Setting Time

Setting times range from 1 to 5 minutes.

The clinical setting time is detected by a loss of surface tackiness. If possible, the impression should be left in place 2 to 3 minutes after the loss of tackiness, because the tear strength and elastic recovery (recovery

from deformation) increase significantly during this period. Color-changing alginates provide a visual indication of working time and setting time (alginate changes its color from light pink to white). Lengthening the setting time is better accomplished by reducing the temperature of the water used with the mix than by reducing the proportion of powder. Reducing the ratio of powder to water reduces the strength and accuracy of the alginate. Selecting an alginate with a different setting time is a better alternative than changing the W/P ratio.

- Elastic Recovery

A typical alginate impression is compressed about 10% in areas of undercuts during removal. The actual magnitude depends on the extent of the undercuts and the space between the tray and the teeth.

- Flexibility

Most alginates have a typical value of 14%. A reasonable amount of flexibility is required for ease of removal of the impression. Most set alginate materials improve in elasticity over time; this minimizes distortion of the material during impression removal, thus permitting superior reproduction of undercut areas. Data clearly indicate that the alginate impression should not be removed from the mouth for at least 3 minutes after gelation has occurred. Because alginate is a viscoelastic material, the speed of removal must be a compromise between a rapid movement and a slower rate that is more comfortable for the patient. Usually an alginate impression does not adhere to the oral tissues as well as some of the elastomers do, so it is easier to break the seal ("suction") first and then remove the alginate impression rapidly. It is always best to avoid torqueing or twisting the impression to remove it quickly.

- Strength

The compressive and tear strengths of alginates are time dependent, with higher values obtained at higher rates of loading. The compressive and tear strengths increase with increasing rates of deformation.
Any deviation from the manufacturer's instructions can have adverse effects on the gel strength. For example, if too much or too little water is used in mixing, the final gel will be weakened, making it less elastic. Insufficient spatulation results in failure of the ingredients to dissolve sufficiently so that the chemical reactions can proceed uniformly throughout the mass. Overmixing breaks up the formation of the calcium alginate network and reduces its strength.
Alginate is a weak material; therefore a sufficient bulk of material is needed. The thickness of the alginate impression between the tray and the tissues should be at least 3 mm.

- Compatibility with Gypsum

The impression must be rinsed well in cold water to remove saliva and any blood, and then disinfected. Next, all free surface water should be removed before preparing a gypsum model. Saliva and blood interfere with the setting of gypsum, and if free water accumulates, it tends to collect in the deeper parts of the impression and dilute the gypsum model material, yielding a soft, chalky surface. The excess surface water has been removed when the reflective surface becomes dull. If the alginate impression is stored for 30 minutes or more before preparing the model, it should be rinsed with cool water to remove any exudate on the surface caused by syneresis of the alginate gel; exudate will retard the setting of the gypsum. Thereafter, it should be wrapped loosely in a moist paper towel and sealed in a plastic bag to avoid moisture loss. The set gypsum model should not remain in contact with the alginate impression for

periods of several hours because contact of the slightly soluble calcium sulfate dihydrate with the alginate gel containing a great deal of water is detrimental to the surface quality of the model.

- Dimensional Stability:

Alginate impressions lose water by evaporation and shrink when standing in air (syneresis) . Impressions left on the bench for as short a time as 30 minutes may become inaccurate enough to require remaking the impression. For maximum accuracy, the model material should be poured into the alginate impression as soon as possible. If for some reason the models cannot be prepared directly, the impressions should be stored in 100% relative humidity in a plastic bag or wrapped in a damp (but not wringing-wet) paper towel. There is a greater chance for distortion the longer the impression is stored.

- Disinfection

Disinfection of impressions is a concern with respect to viral diseases such as hepatitis B, acquired immunodeficiency syndrome, and herpes simplex, because the viruses may be transferred to gypsum models and present a risk to dental laboratory and operating personnel. All alginate impressions should be disinfected before pouring with gypsum to form a cast. The most common form of disinfection is spraying, but studies have shown that alginate impressions can be immersed in sodium hypochlorite or iodophors.

- Accuracy

They are not accurate enough for fixed partial denture impressions.

- Advantages

1. Inexpensive.
2. Easy to manipulate.
3. Pleasant tasting.
4. Able to displace blood and body fluids.
5. Hydrophilic.
6. Easily poured in stone.
7. They can be used with stock trays.

- Disadvantages

1. Alginates tear easily.
2. Must be poured immediately after removal from the mouth.
3. Have limited detail reproduction.
4. Dimensionally unstable, and can only be used for single casts.
5. The gypsum compatibility varies with the brands of alginates and dental stones used. They are incompatible with many epoxy resin die materials.

❖ Agar (Reversible Hydrocolloid)

The sol–gel transformation of agar is a physical phenomenon induced by temperature change. The gel liquefies when it is heated to 70 to 100 °C, which is known as the liquefaction temperature, and the sol solidifies around 37 to 50 °C, which is known as the gelation temperature. Thus agar is called a reversible hydrocolloid. The gelation temperature is critical for impression making. If it is too high, the heat from the sol may injure the oral tissues. Conversely, if the gelation temperature is too far below oral temperature, it will be impossible to make the impression because the sol will not convert to a gel in the oral cavity.

Hysteresis of agar is the phenomenon of a gel's having a liquefaction temperature different from the solidification temperature of the sol.

The agar hydrocolloid is usually supplied in two forms, syringe material and tray material.

Uses:

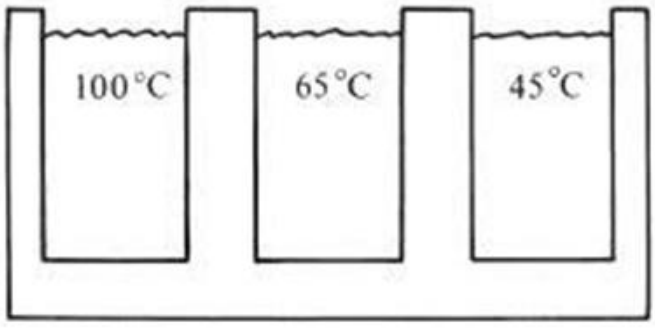
1. For full-mouth impressions without deep undercuts.
2. Quadrant impressions without deep undercuts.
3. Single impressions (less frequently).
4. Because of their high accuracy, they can be used for fixed partial denture impressions.

Composition:

1. Gelling agent: agar (12% to 15%).
2. Borax (0.2%) or other fillers—such as diatomaceous earth, clay, silica, wax, rubber, and similar inert powders—are used to control strength, viscosity, and rigidity.
3. Potassium sulfate (1% to 2%) to provide good surfaces on gypsum models or dies.
4. Alkylbenzoates (0.1%) as preservatives.
5. Coloring and flavoring agents (traces) for ease of "reading" the impression and esthetics.
6. The balance of the formulation (~85%) is water. The syringe consistency is prepared by increasing the water content and decreasing the agar content.
7. Thymol may also be added as a bactericidal agent.
8. Glycerin may also be added as a plasticizer.

Making Agar Impression:

This process requires a three-compartment conditioning unit for the agar tray material that allows liquefaction, storage, and tempering; the agar syringe material is used only in the liquefaction and storage compartments.



The following sequence is used:

1. Heat in water at 100°C for 8 to 12 minutes.
2. Store in water at 65°C.
3. Place in a tray (containing cooling coils) at 65°C.
4. Temper in 46°C water for 2 minutes before taking the impression.
5. After seating the tray, cool it with water at no less than 13°C until gelation occurs.
6. After the impression is removed from the mouth, wash it to remove saliva, which will interfere with the setting of the gypsum.
7. Shake off excess water and lightly blow off remaining excess with air.
8. Disinfect the impression.
9. Pour mixed dental stone into the impression. If the impression is stored for a short time in 100% relative humidity, it should be washed as described in steps 6 and 7 to remove any exudate on the surface caused by syneresis (the exudation of water, accompanied by contraction) before pouring the cast.
10. After the initial setting of the stone, store the gypsum cast and impression in a humidor. Agar impressions become less accurate during storage, so prompt pouring of gypsum casts is necessary.

Hydrocolloid materials exhibit viscoelastic behavior; therefore it is necessary to remove the impression with a snap and not to tease it out. Any twisting or flexure should be avoided.

Advantages:

1. Inexpensive.
2. Have no unpleasant odors.
3. Nontoxic.
4. Non-staining.
5. They do not require a custom tray or adhesives.
6. The components do not require mixing.
7. These materials are hydrophilic and can be used in the presence of moisture and are able to displace blood and body fluids.
8. They are easily poured in stone, and the stone casts are easily removed from the hydrocolloid impressions.

Disadvantages:

1. These materials require the use of expensive equipment and must be prepared in advance.
2. They tear easily.
3. Must be poured immediately.
4. Dimensionally unstable.
5. Can only be used for single casts.
6. Cannot be electroplated. The surface of stone casts will be weakened by compositions containing borax.