Dental waxes

What are waxes used for?

- Waxes have a variety of uses in clinics and laboratories.

In clinics	In laboratories
Bite registration	Boxing techniques
Alterations and adaptation for impression trays	Baseplate for complete and partial dentures
Direct waxing for cast restorations	Hold components before articulation
____________	Indirect pattern for casting

COMPOSITION

- Natural waxes produced from:
  - Plants
  - Minerals: paraffin wax
  - Animals: beeswax
- Synthetic waxes
- Additional components: gums, oils, resins, fats.

PROPERTIES

1. Melting range: a range of temperatures at which each component of the wax will start to soften and then flow. The operator can control the viscosity of wax by controlling temperature.
2. Flow: is the movement of the wax as molecules slip over each other. Melting range and flow of the wax are important in wax manipulation by operator. E.g. bite registration wax?

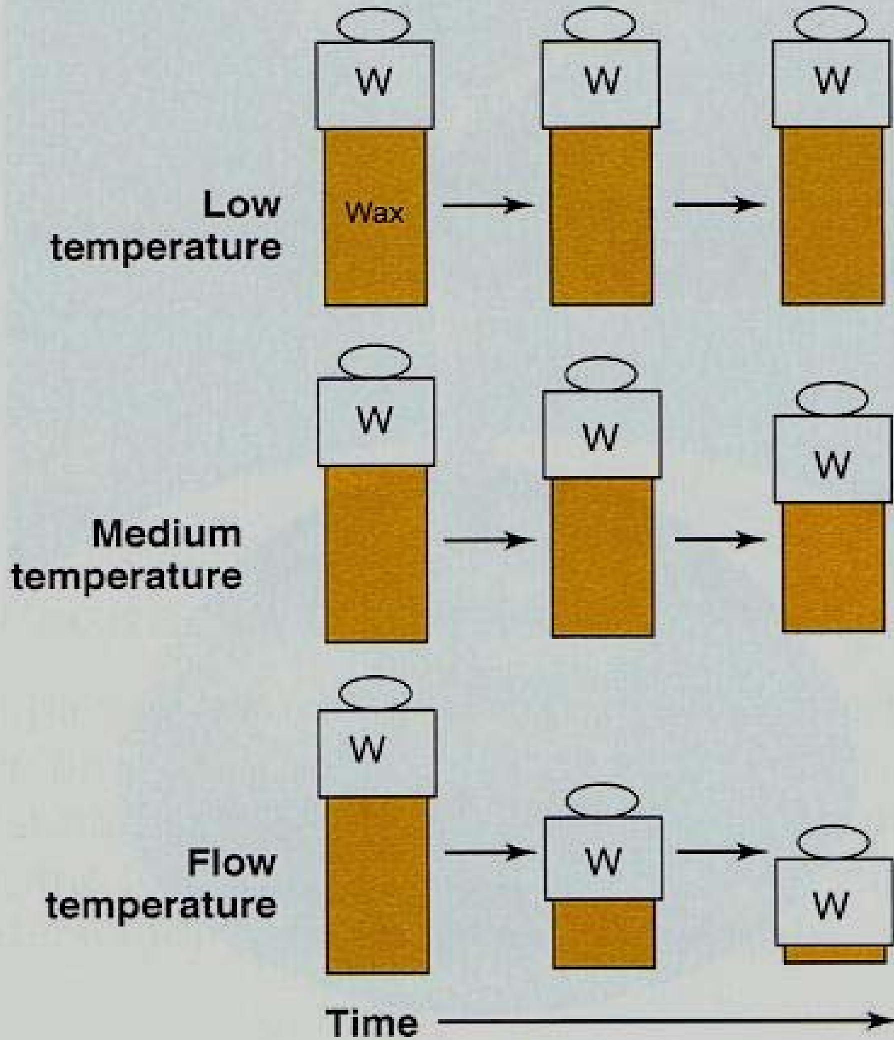


FIGURE 10–3 Flow of wax. Flow is a function of time and temperature. If a small weight, *W*, is placed on top of a cylindric wax sample *(shaded area)*, no change in height occurs if the wax is at a low temperature relative to its flow temperature, *top row*. As the temperature approaches the flow temperature, some change in dimension occurs over time, *Medium temperature, second row*. At the flow temperature, large changes in dimension occur, *Flow temperature, bottom row*. In all cases, the amount of flow is time dependent and usually is expressed as a percentage of the original height.

PROPERTIES

3. Excess residue: for the sake of accuracy in the object produced, if excess residue remains after melted wax is removed, inaccuracies may occur. (lost wax technique procedure)

PROPERTIES

4. Dimensional change: waxes expand when heated, contract when cooled. Thermal expansion of waxes is highest among dental materials. This property is important especially for pattern waxes (e.g. inlay wax). How:
   - If wax is heated well beyond melting range or unevenly, unacceptable expansion occurs.
   - If wax is allowed to stand for a long time, the release of residual stresses will lead to dimensional changes and inaccuracies. This is why pattern wax should be invested within 30 minutes of carving.

CLASSIFICATION OF WAXES

Pattern wax	Processing wax	Impression wax
Inlay wax	Boxing wax	Corrective impression wax
Casting wax	Utility wax	Bite registration wax
Baseplate wax	Sticky wax	____________

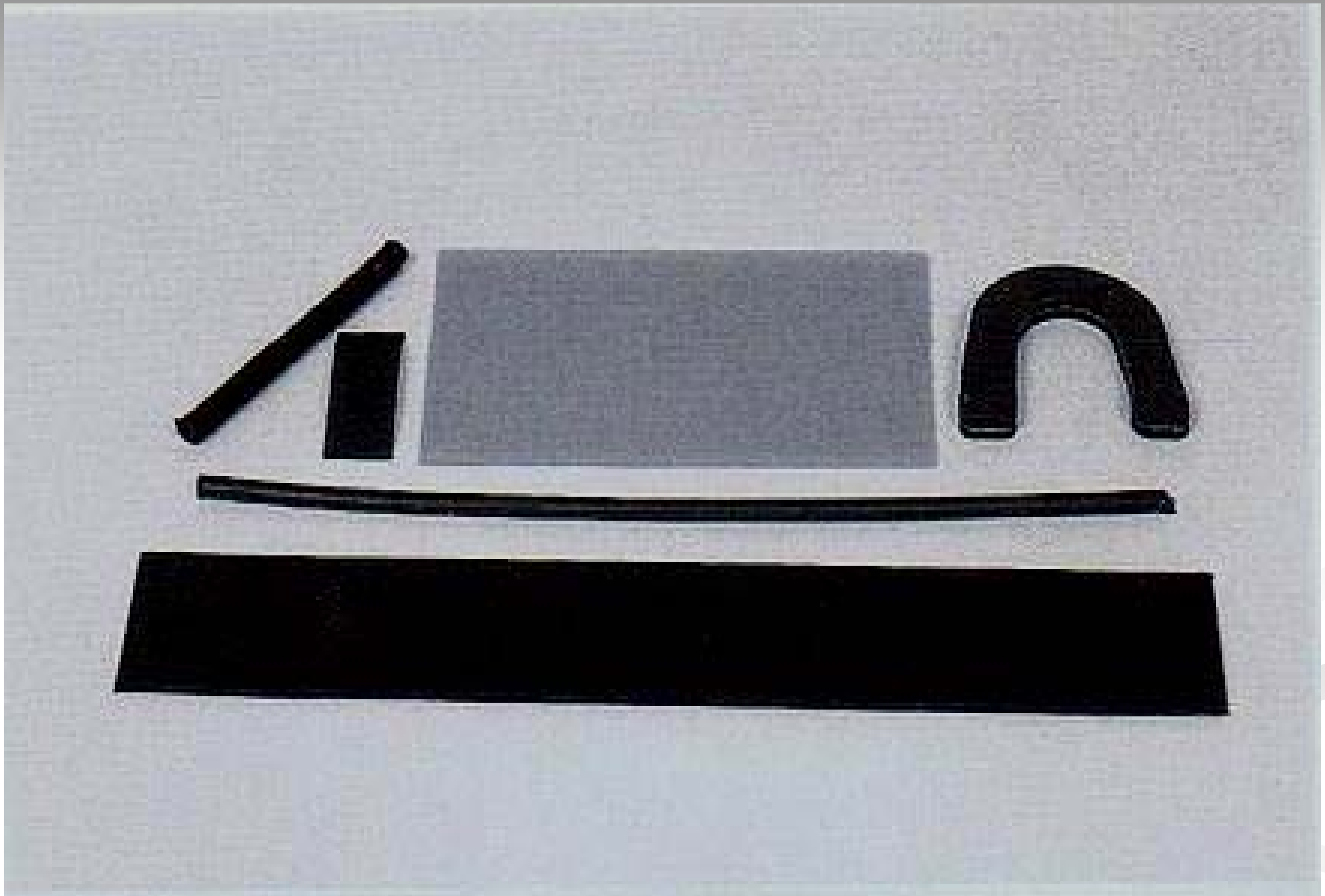


FIGURE 15-1 Various forms of wax: sheets, ropes, and sticks.

PATTERN WAXES

- Inlay waxes: are used to produce patterns for metal casting using the lost wax technique.

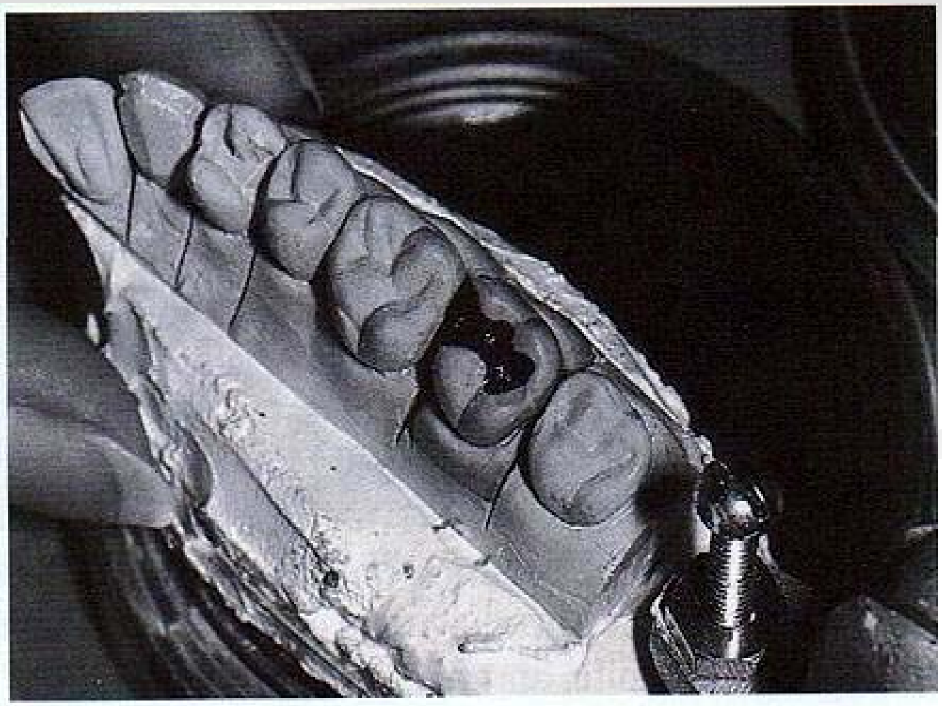


FIGURE 15-2 Inlay waxing on a die.

FIGURE 15-5 ■ Waxing of inlays and crown.

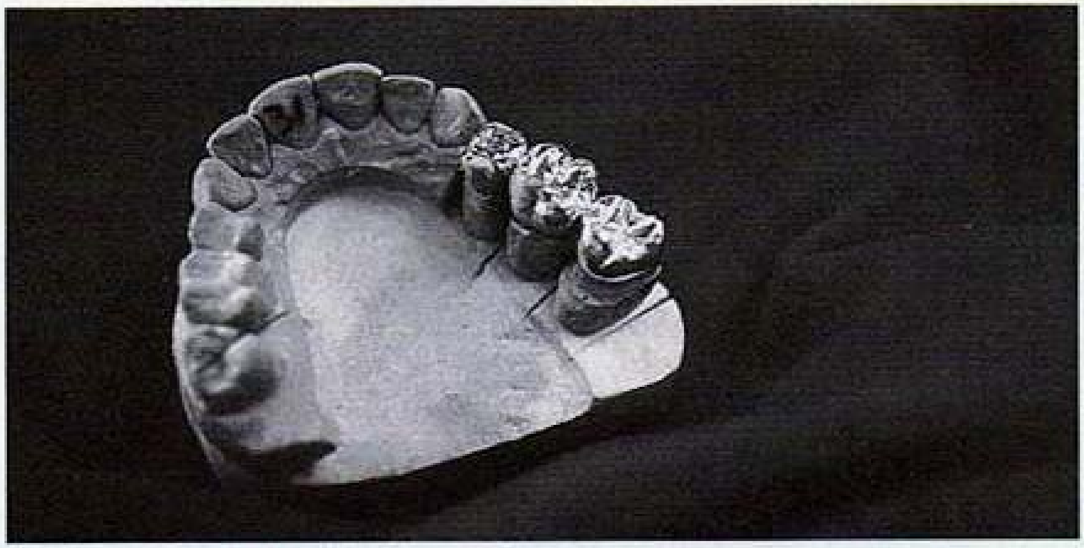


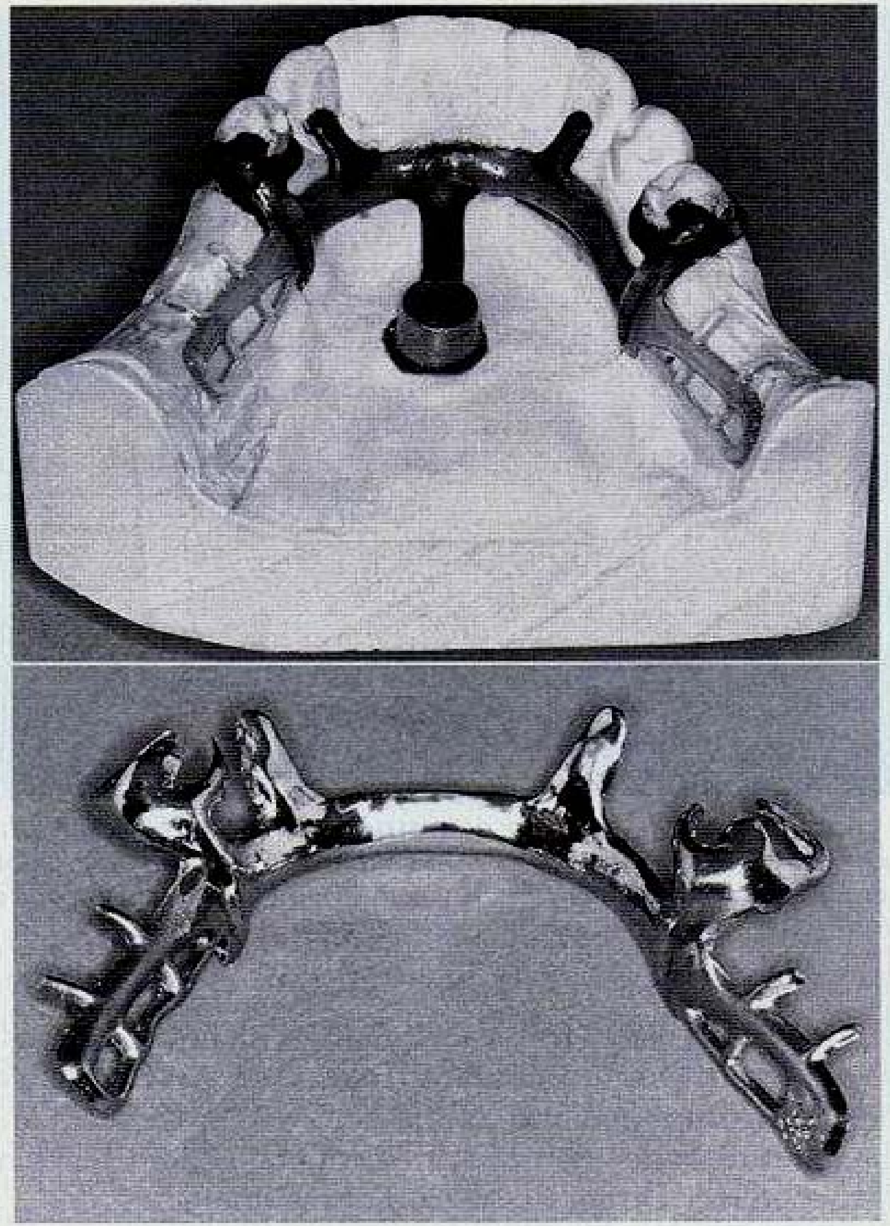
FIGURE 15-6 ■ Cleaned and polished metal castings of inlays and crowns.

Continue,

- Type I: placed directly in the prepared tooth in the direct waxing technique. This wax has a low melting range.
- Type II: melted on a die outside the mouth in the indirect technique (more commonly used). These waxes are supplied as pellets and sticks. They are blue and green in color. Hard, medium, soft depending on melting range.

Continue,

- Casting wax: used to construct the metal framework for partial and complete dentures. Supplied in sheets or preformed shapes.



A

B

FIGURE 10-5 **A,** A gypsum cast with a partial denture framework formed of casting wax. **B,** Partial denture framework after casting by means of the lost-wax technique. Note: the sprue has been removed and the metal framework has been polished.

Continue,

- Baseplate wax: sheets of wax pink in color. These sheets are layered to produce the form on which denture teeth are set

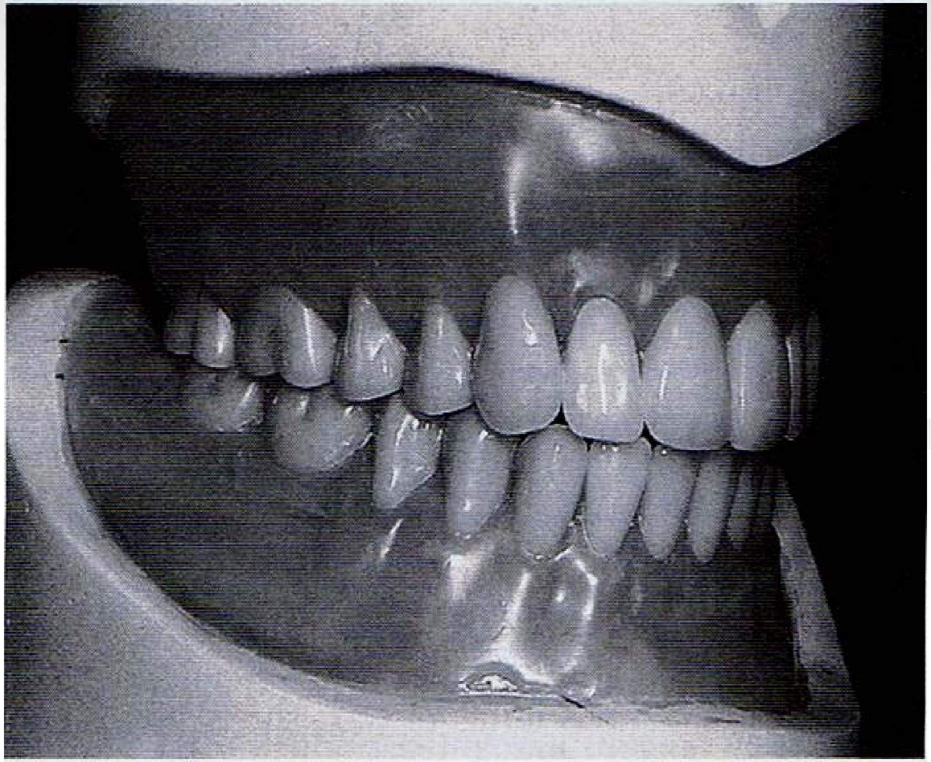


FIGURE 15-3 ■ Denture setup on baseplates.

PROCESSING WAX

- Boxing wax: used to form the base portion of a gypsum model. Easily manipulated at room temperature.

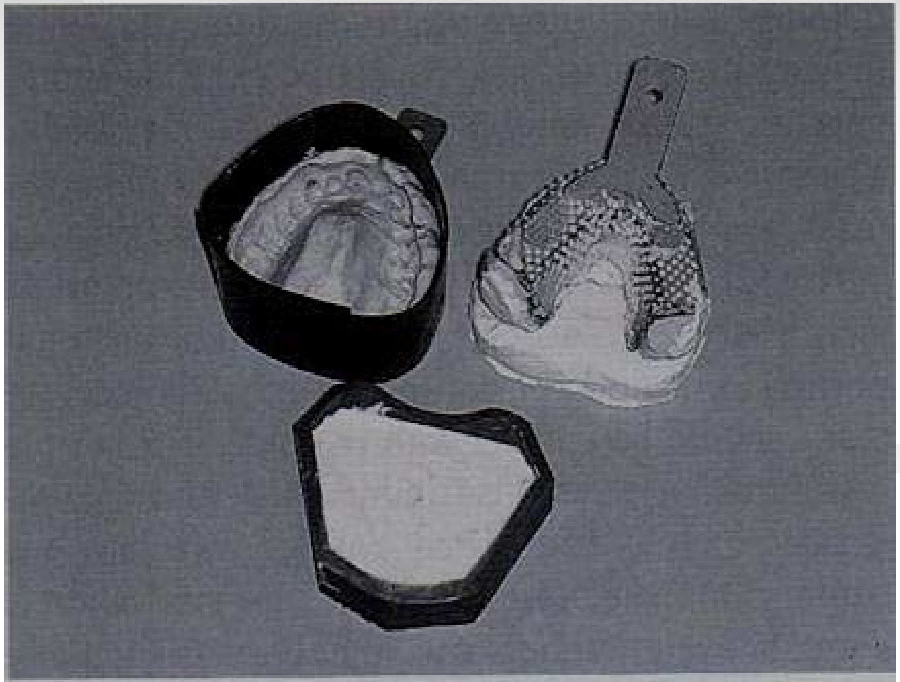
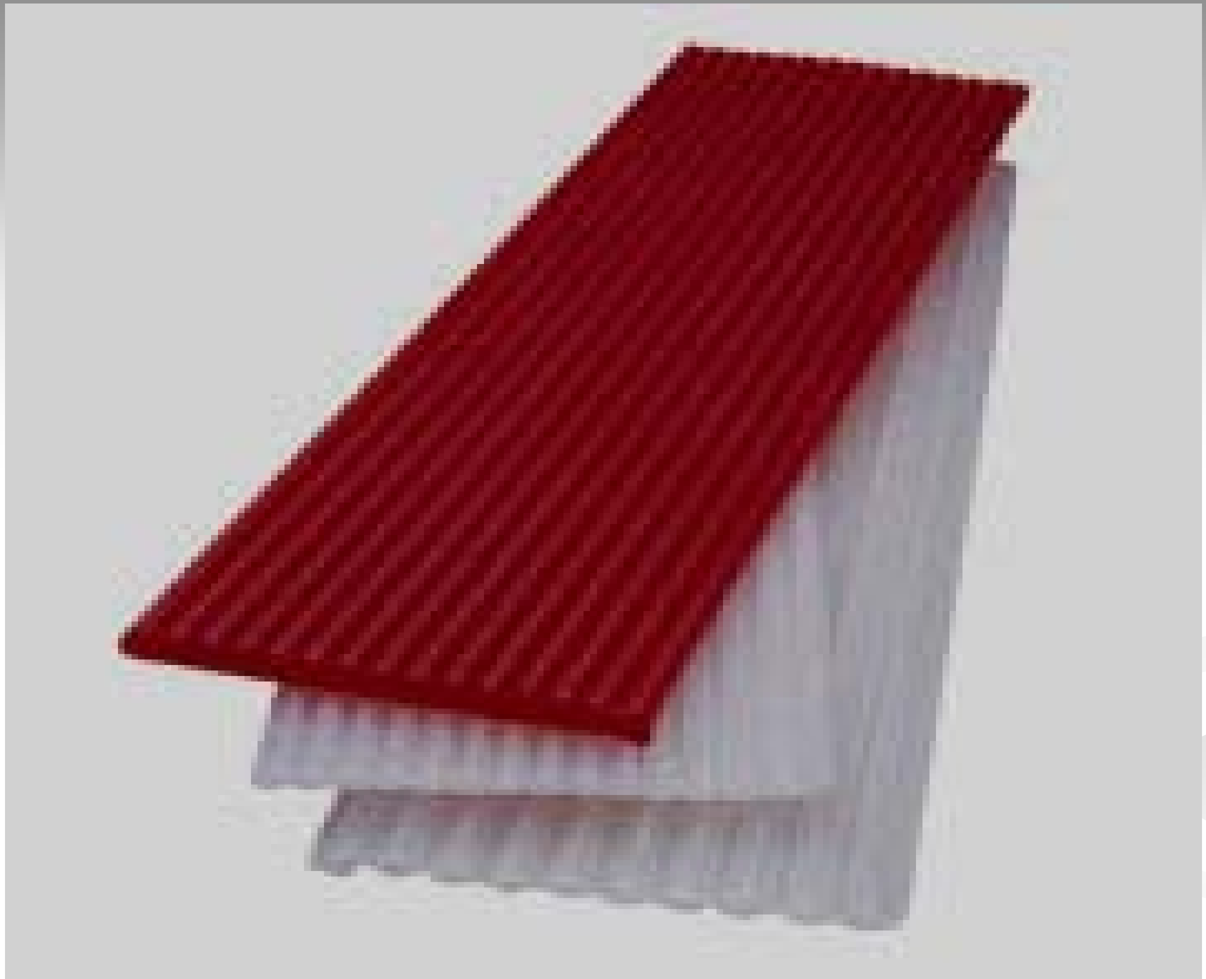


FIGURE 12-3 ■ Pouring the art portion of the cast by boxing, model former, and inversion on patty base.

Continue,

- Utility wax: also called periphery wax, comes in ropes, and easily manipulated at room temperature. Used to adjust impression trays, used to cover sharp brackets and wires in orthodontic appliances, layered in sheets for bite registration.



Utility wax

Continue,

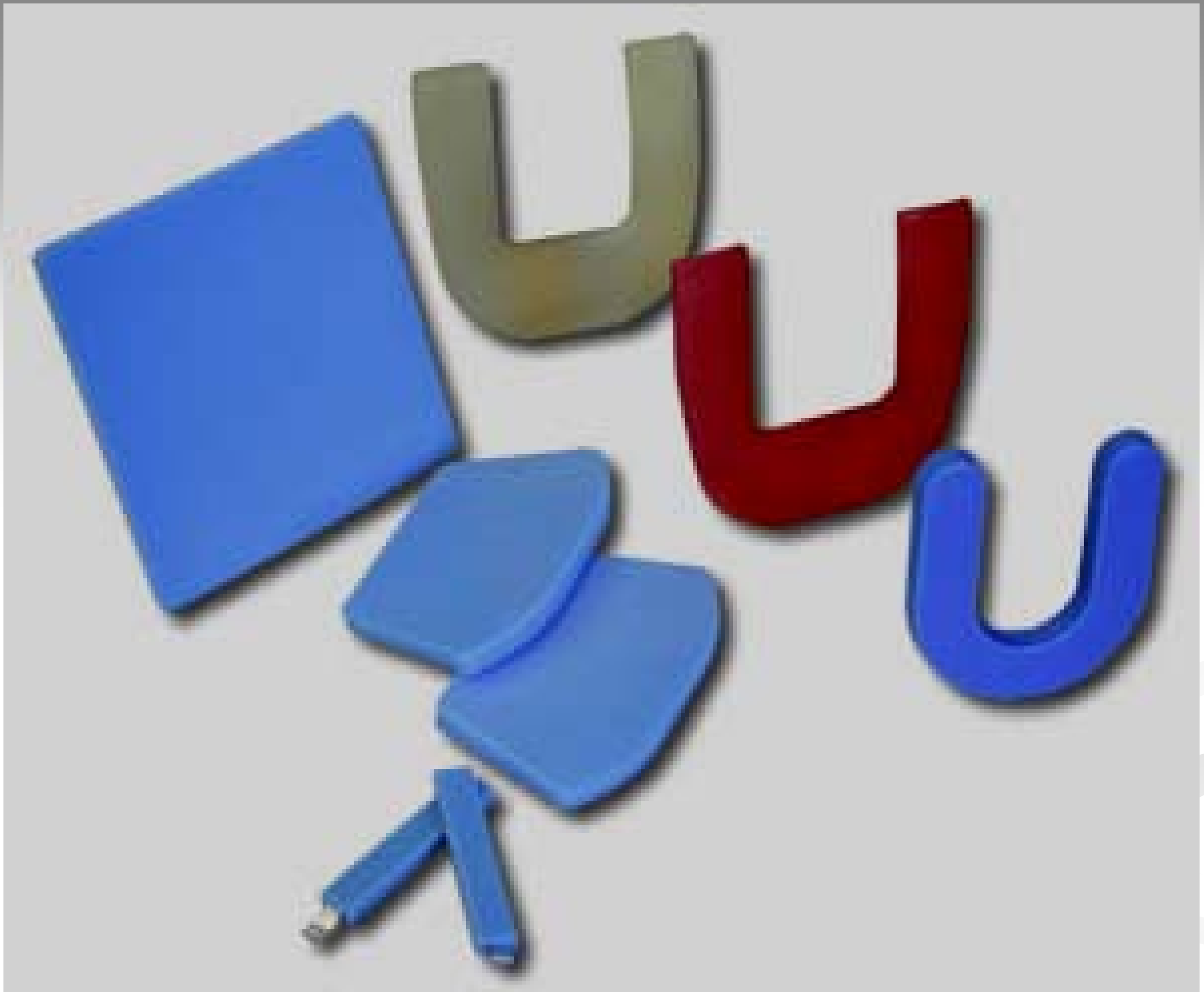
- Sticky wax: comes in orange sticks that are hard and brittle at room temperature. When heated, become soft and sticky. Used to adhere components of metal, gypsum, resin during fabrication and repair.

Sticky wax

IMPRESSION WAXES

- Corrective impression wax: used with other impression materials for edentulous impressions, to correct undercut areas. Flows at mouth temperature.
- Bite registration: to produce wax bite registration for articulation of models. Susceptible to distortion, needs careful handling.

Wax sheets used for impression and bite registration



Wax sheets, horseshoe shaped, rods

MANIPULATION

- Softened evenly in:
  - Warm hands
  - Dry heat
  - Flame
- Added in layers into an object
- Should be invested within 30 minutes of carving
- Utility and boxing wax should remain dry to allow to stick when manipulated.
- Should be stored at or slightly below room temperature

Lost wax technique

1. An impression of the preparation is taken and poured into high strength stone to form a die.
2. Wax pattern is carved
3. Wax or plastic sprue is attached to pattern
4. Pattern and sprue are encased in investment ring, into which investment gypsum is poured
5. Once investment sets, wax pattern and sprue are heated in a burnout oven, causing wax and sprue to vaporize (lost wax), leaving an impression of wax pattern in the empty case

Lost wax technique continue,

6. Molten metal is poured through the empty channel formed by sprue, into the empty wax pattern space.
7. Metal cools, sprue removed, casting cleaned and polished and now ready for cementation

Lost wax technique

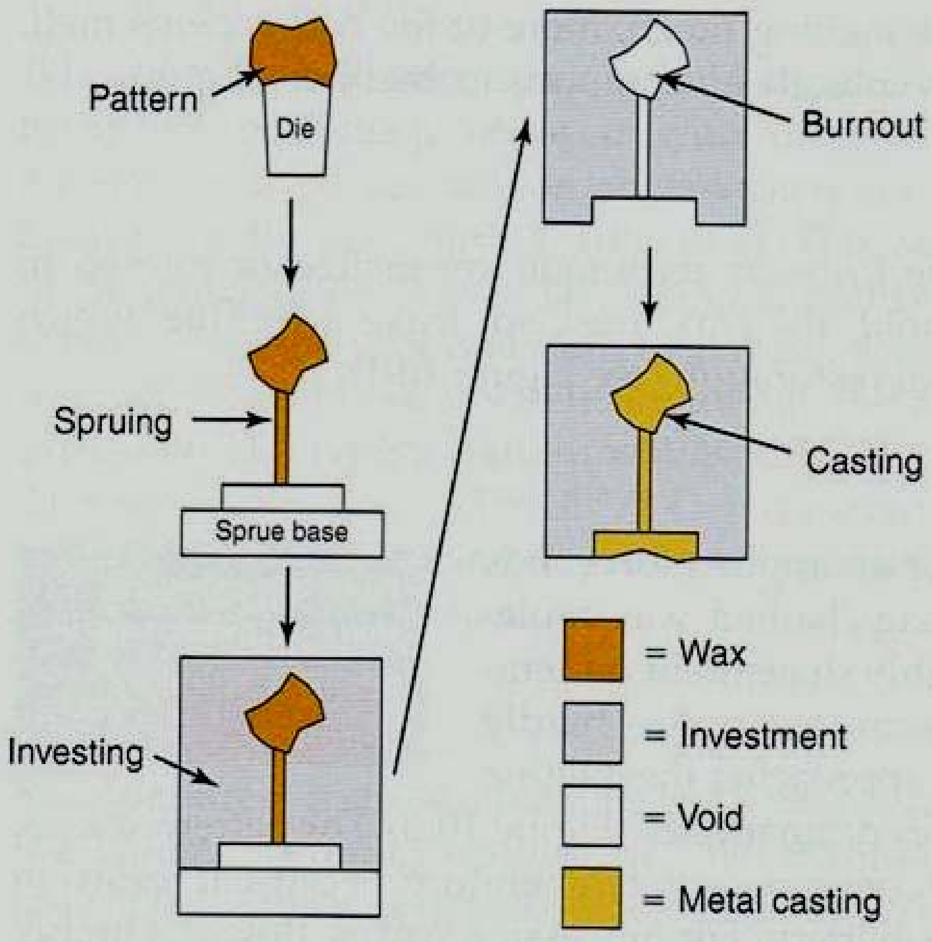


FIGURE 10–1 Lost-wax technique. A wax pattern of the tooth is made on a die with a pattern wax (usually inlay wax). A sprue, sprue base, and casting ring are added, and then the sprue and pattern are invested (filled) with a gypsum-based material. After the investment sets, the base of the sprue holder is removed, and the invested pattern and sprue are placed into an oven to burn out the wax (hence the name "lost wax"). Once the wax is burned out, a space remains where the sprue and wax pattern were. The molten metal is cast into this space.

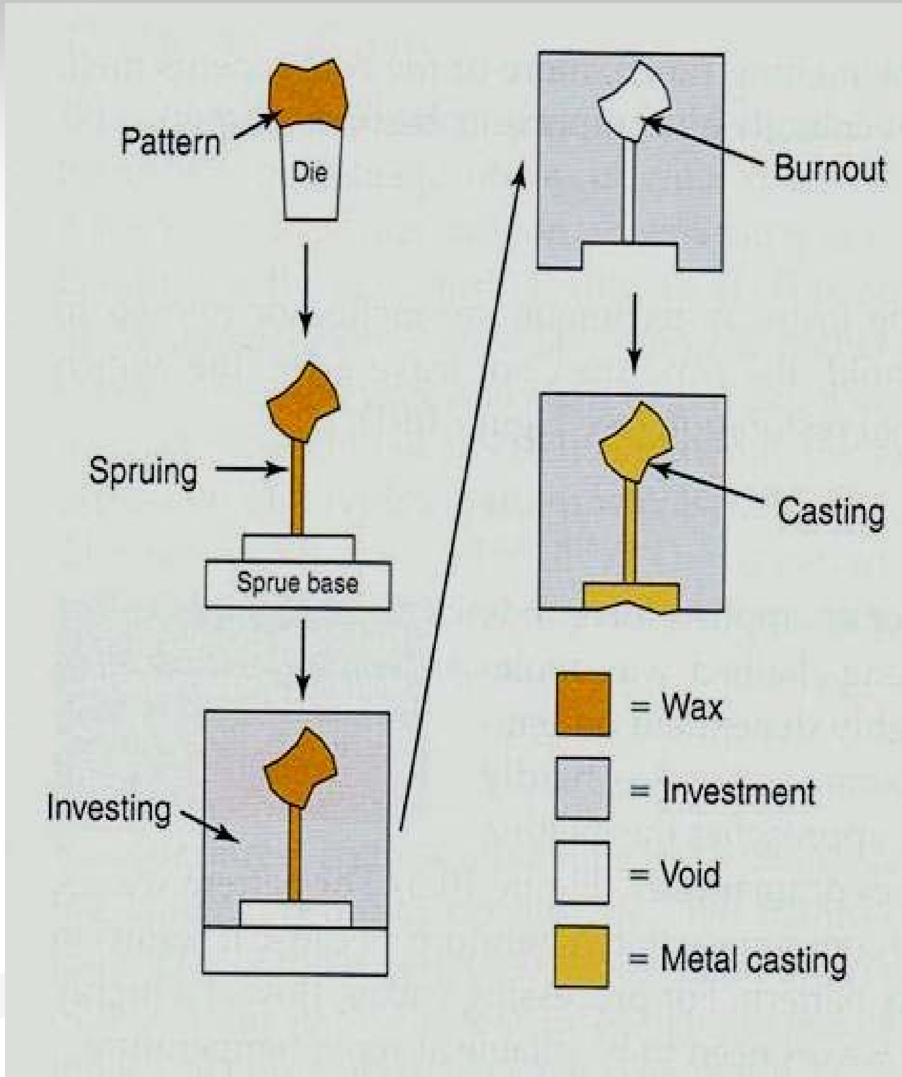
REFERENCE

- Dental materials, clinical applications for dental assistants and dental hygienists
- Chapter 15

Investment and refractory dies

Introduction

- Production of wax pattern
- Sprue attachment
- Assembly placed in casting ring
- Investment material poured
- Wax burnout
- Alloy or ceramic poured



Requirements of investment

- Accurate reproduction of details on the wax pattern
- Maintain shape and integrity at high temperatures
- High value of compressive strength
- Setting expansion and thermal expansion to compensate

How do you choose investment material

- Based on:
  - Casting temperature
  - Type of alloy to be cast
- Available material:
  - Gypsum bonded
  - Silica bonded
  - Phosphate bonded

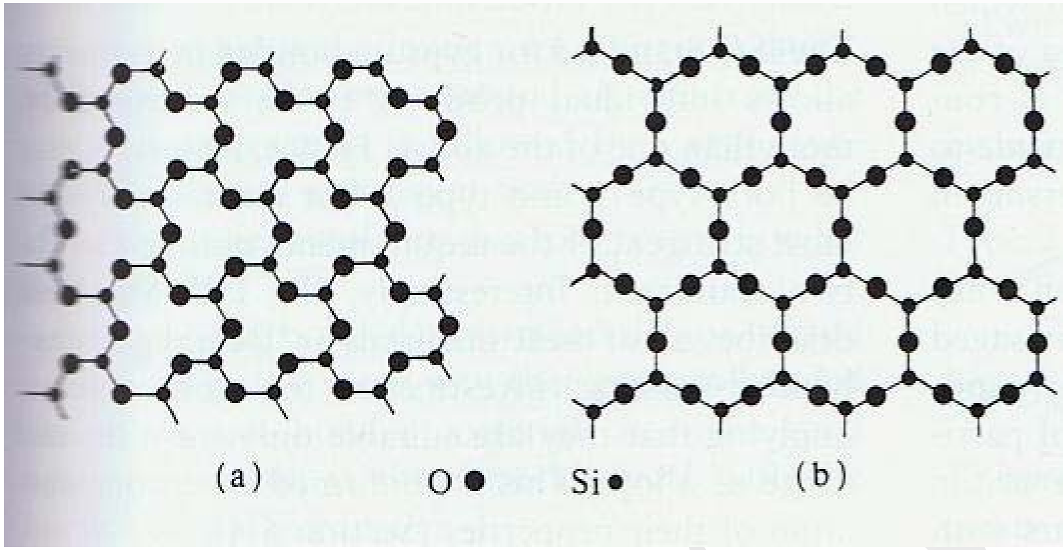
Gypsum bonded materials

- Composition:
  - Silica (SiO_2)
  - Calcium sulphate hemihydrate
  - Powdered graphite or copper
  - Boric acid, sodium chloride

Gypsum-bonded investment

Continue,

- Silica:
  - Withstand high temperature
  - Provide expansion: thermal, crystalline inversion
  - 3 forms:
    - Quartz
    - Cristobalite
    - Tridymite



Continue,

- Calcium sulphate hemihydrate
  - Setting expansion
  - Hygroscopic expansion. How does it work?
  - Water added expansion

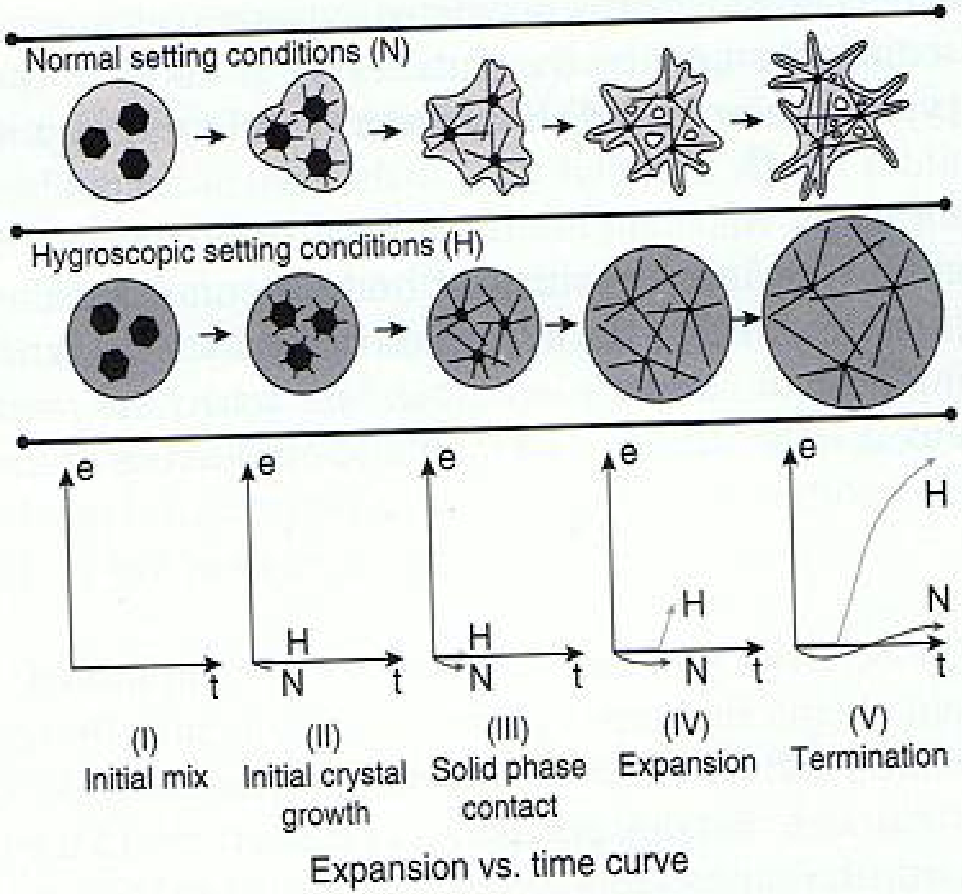


Fig. 10-8 Diagrammatic representation of the setting expansion of plaster. In the left column, the crystal growth is inhibited by the lack of excess water. As shown in the right column, water added during setting provides more room for longer crystal growth. *e,* expansion; *t,* time; *H,* hygroscopic setting expansion; *N,* normal setting expansion. (From Mahler DB, and Ady AB: Explanation for the hygroscopic setting expansion of dental gypsum products. J Dent Res 39:578, 1960.)

Types of gypsum bonded investment

- Type 1: thermal expansion type for inlays and crowns
- Type 2: hygroscopic expansion type, inlays and crowns
- Type 3: for complete and partial dentures

Silica bonded materials

- Composition:
  - Powdered quartz or cristobalite bonded together with Silica gel (alkaline conditions:

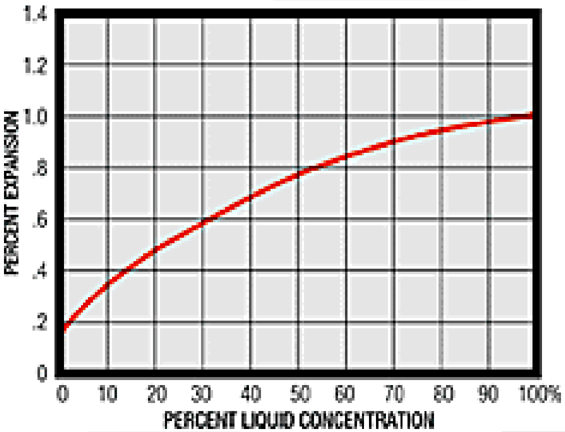
*binder solution formation:

$$(C_2H_5O)_4Si+4H_2O \longrightarrow Si(OH)_4+4C_2H_5OH$$

Continue,

- To add strength to the material, as much powder as possible is added.
- Contraction occurs on heating, followed by expansion (thermal and inversion expansion).

Phosphate-bonded investment



For high-melting point alloys

Phosphate bonded materials

- Composition of powder:
  - Silica
  - Magnesium oxide
  - Ammonium phosphate
- Reaction: mixed with water or colloidal silica: magnesium ammonium phosphate which bonds silica to form set investment

Continue,

- Expansion:
  - Crystal growth
  - Hygroscopic expansion
  - On heating prior to casting:
    - Thermal expansion
    - Silica inversion
  - Difference between mixing with water or colloidal silica?

Continue,

- Types of phosphate bonded materials:
  - Type 1: inlays and crowns
  - Type 2: removable prosthesis like removable dentures

Properties of investment

- Thermal stability:
  1. Gypsum bonded: decompose above 1200°C:

$$CaSO_4 + SiO_2 \longrightarrow CaSiO_3 + SO_3 \text{ (gas)}$$

  - Results:
    - Porosity
    - Weakening of gypsum
- This investment is not appropriate for metals with high casting temperatures

Continue,

- Other reactions above 700°C:

$CaSO_4 + 4C \longrightarrow CaS + 4CO$

$CaSO_4 + CaS \longrightarrow CaO + 4SO_2$ (gas)

Oxalate: used to decrease effect of decomposition by liberating carbon dioxide at high temperatures

Thermal stability continue,

Phosphate bonded and silica bonded are stronger. More suitable for casting base metal alloys and all other alloys

Properties

- Porosity: higher in gypsum and phosphate bonded to allow escape of air. Less in silica bonded, so pressure may build up (incomplete mould filling and porosity result)
- Solution?

Properties

- Compensation expansion: to compensate for shrinkage of alloys upon cooling
- Magnitude of shrinkage for alloys:

Gold alloys	1.4%
Ni/Cr	2.0%
Co/Cr	2.3%

Continue,

- Compensation:
  - Setting expansion
  - Thermal expansion
  - Crystal inversion
  - Hygroscopic expansion

Continue,

- Gypsum bonded:
  - 0.3% setting expansion, increases to
  - 1.3% by hygroscopic expansion
  - Thermal expansion is higher with cristobalite
- Silica bonded: 1.6% upon heating. At first contraction occurs
- Phosphate bonded:2% setting and thermal exp.

Applications

- Phosphate bonded are more commonly used
- Silica bonded are rarely used

Investment	Use
Plaster & stone	Mould for acrylic dentures
Gypsum bonded	For gold casting alloys
Silica bonded	For base metals
Phosphate bonded	For base metal and gold. Cast ceramics Refractory die for ceramic build up

Casting of dental materials

Casting process

- Making wax pattern
- Spruing the pattern
- Investing
- Burnout
- Casting
- Removal of investment
- Pickling
- Finishing

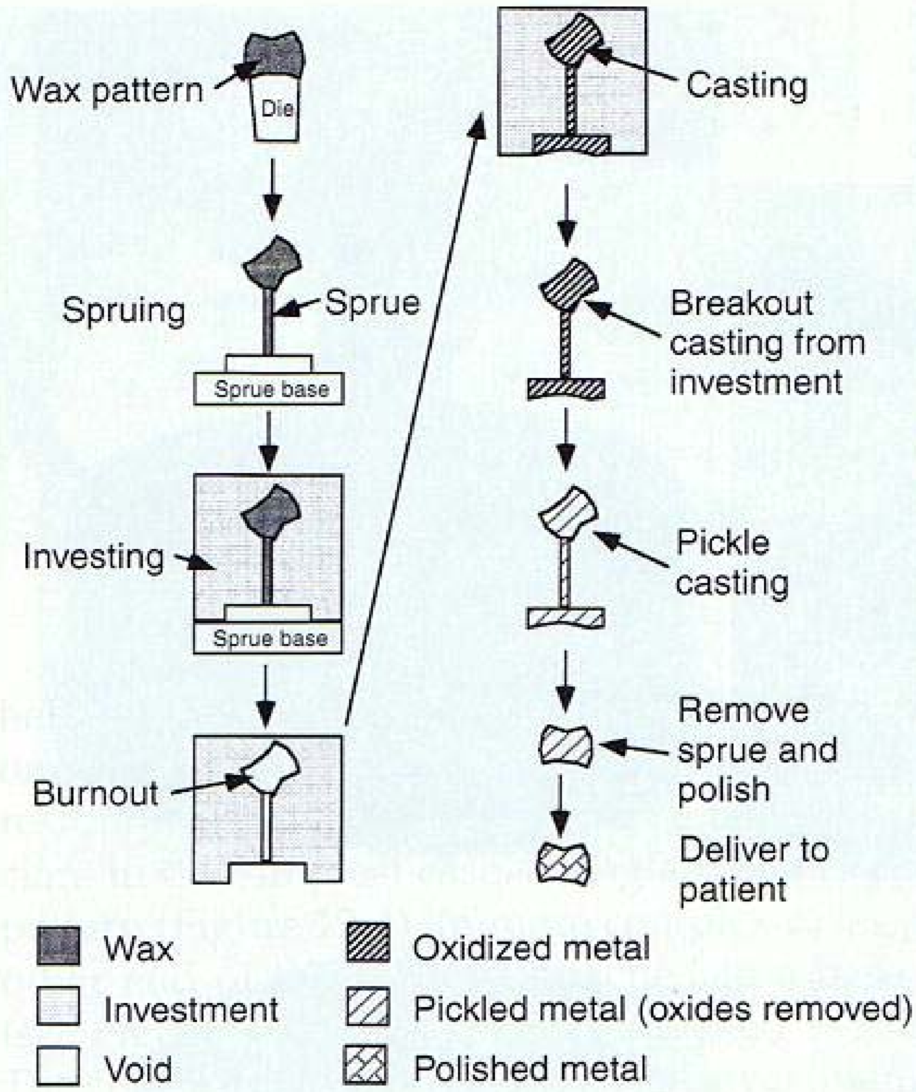
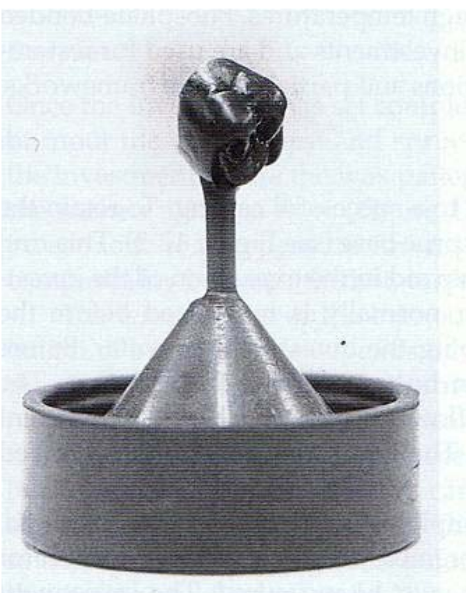
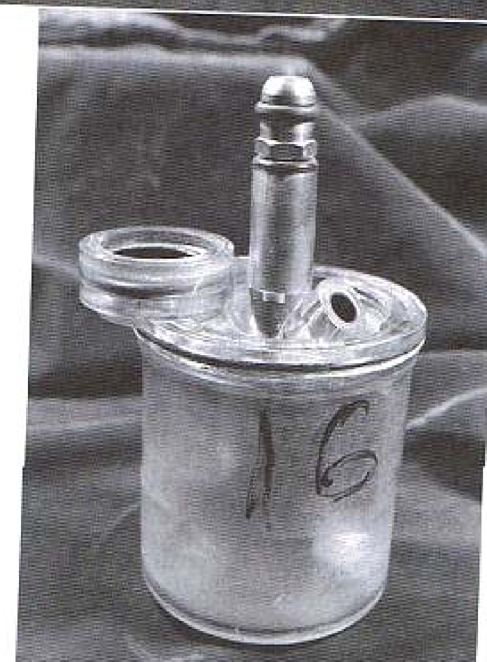


FIGURE 12-1 The casting process. A wax pattern is made on a die (replicate of the prepared tooth). The pattern is then sprued, invested, and the wax is burned out in an oven. At this point, a space in the investment is exactly the same shape as the pattern and sprue. Molten metal is then cast into the space, and after cooling the investment is broken away from the casting. The casting is then pickled to remove oxides, the sprue is removed, and the casting is polished. At this point, the casting is ready to be delivered to the patient.

- Waxing and spruing:
  - Wax pattern formed on dies (indirect)
  - Sprue:
    - Material that forms a channel through which metal travels. Made of wax, plastic, metal
    - Should be as big and as short as possible
- Investing:
  - Casting ring is placed onto the sprue base
  - Moistened ceramic paper liner on inside of ring
  - Surfactant is sprayed on the wax pattern
  - Mixing done in vacuum
  - Investment poured, vibrator used

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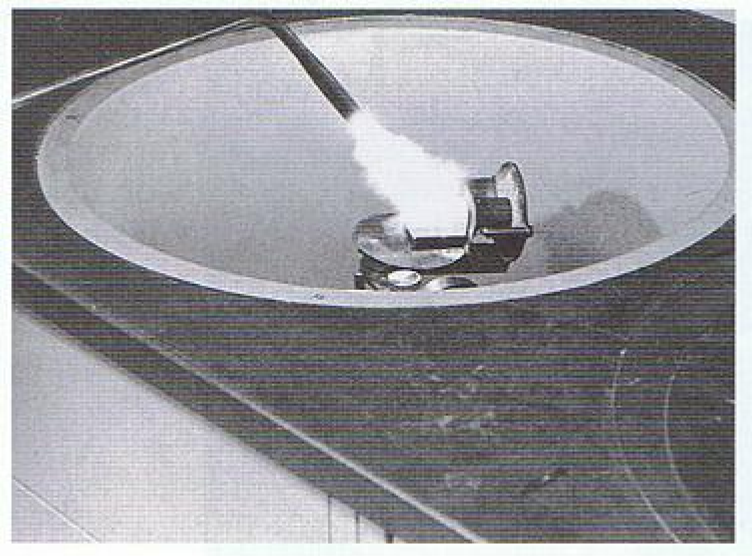
- Burnout:
  - To melt away the wax
  - Causes expansion of the investment. Also allows escape of gas and steam
  - Depends on type of alloy. E.g.:
    - Gold: slow at 450°C or rapid at 700 °C
    - Ni/Cr: 700-900 °C
    - Co/Cr: 1000 °C
  - Metal casting should start as soon as the casting rings heats up to prevent distortion or cracking of investment if the ring cools

- Casting:
  - Done in a centrifugal casting machine. Also air pressure and steam maybe used to drive metal into mould
  - Metal is heated in a ceramic resistant crucible
  - Fluxes are used to prevent oxides forming on metal surface
  - Process takes less than 1 second
  - Metal is melted by:
    - Blowtorch
    - Electric current (induction casting)
  - Cooling is done on bench or in water (quenching)



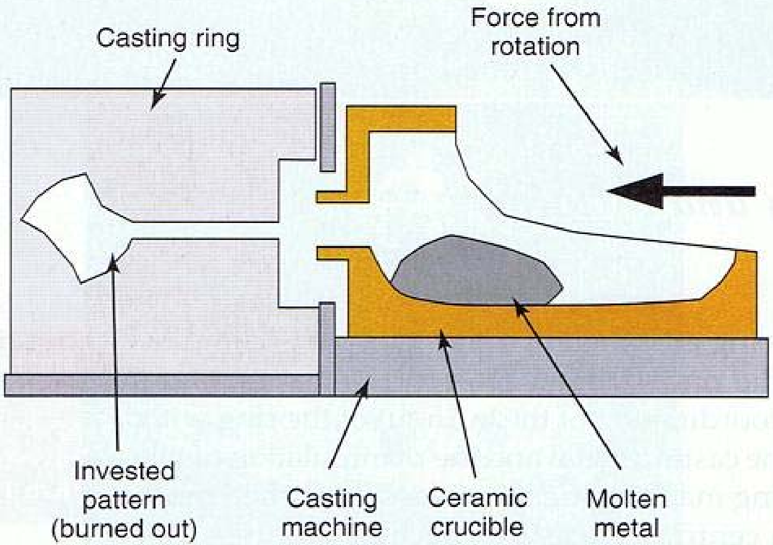


FIGURE 12–8 A diagram of the relationship between the ceramic crucible, casting ring, and casting machine just before casting. The rotation of the casting machine places a tremendous force on the molten metal that is then rapidly moved out of the crucible, through the sprue, and into the space for the pattern. The entire casting process takes less than one second.

- Pickling: removes oxides on surface of cast restoration by soaking it in acid (5-10 seconds in sulfuric acid)
- Finishing and polishing:
  - Sprue is removed by carborundum disc
  - Gross re-contouring using carborundum stones or green stones
  - Polishing done through steps that are progressively finer
  - Always protect margins, contact areas

Faults

- Balance is important between mould temperature and molten metal to produce accurate casting with fine grain structure
- Metal should remain hot so it will flow and fill out the space provided, otherwise deficiencies occur
- Mould should be hot enough to prevent premature crystallization of metal but not too hot which delays crystallization

Faults in castings

1. Finning and bubbling:
    1. Finning: heating investment too rapidly, cracking occurs
    2. Bubbling: spheres form on surface of casting due to porosities on surface of investment (use vacuum when mixing)

Continue,

2. Incomplete casting:
    1. May occur at the site of sprue attachment on casting. Where is the best place to place sprues?
    2. Insufficient thrust of metal during casting. Thrust depends on:
        1. Density of alloy
        2. Speed
        3. Length of the arm

Continue,

3. Back pressure effects: build up of pressure maybe prevented by using a perforated base for the casting ring
4. Cooling shrinkage: may cause voids unless more metal is allowed to inter to compensate

Continue, faults

3. Porosity:
   1. Surface pitting, or underneath surface after finishing and polishing
   2. Gaseous porosity
4. Under or oversized casting: maybe due to lack of balance between metal shrinkage and investment expansion

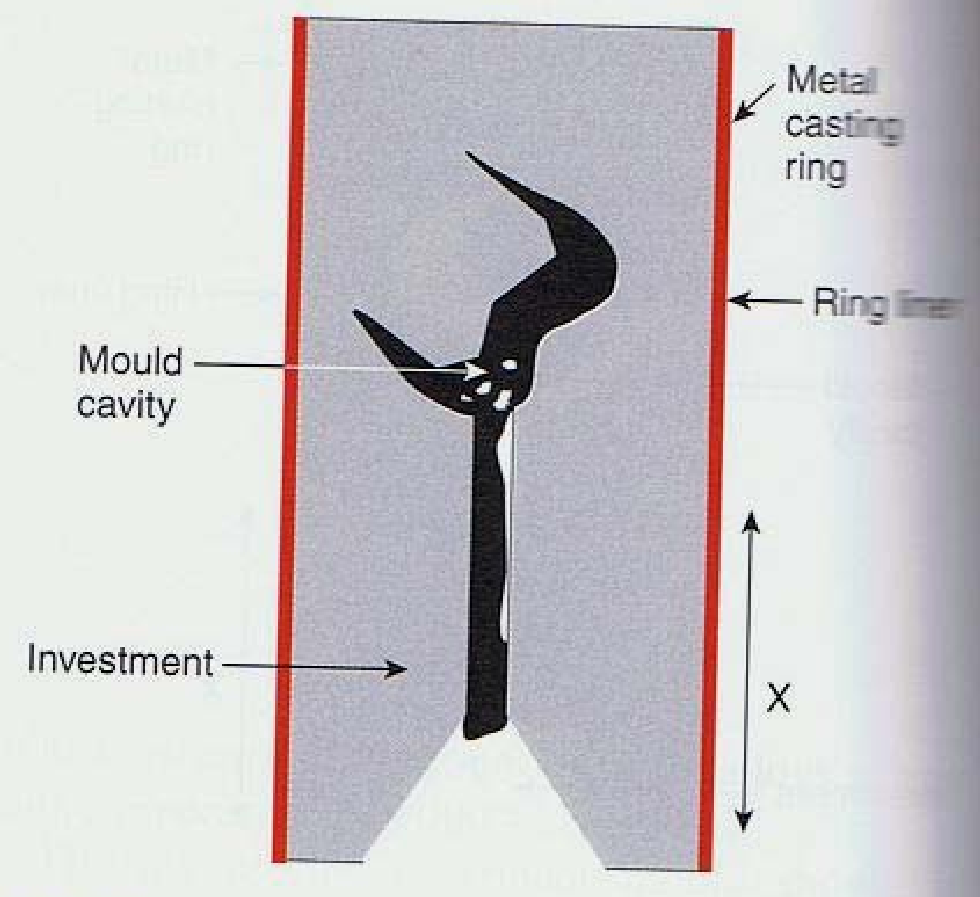


Fig. 9.2 Diagram illustrating a casting fault occurring at the base of the sprue.

References

- Applied dental material
- Dental materials, properties and manipulation