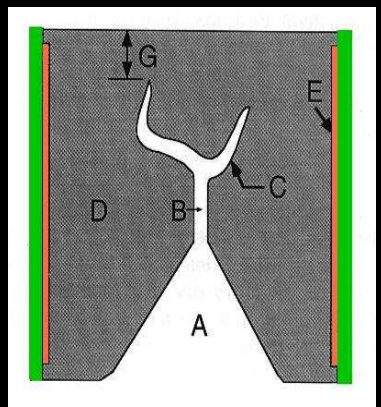

Good morning

# INVESTMENT MATERIALS

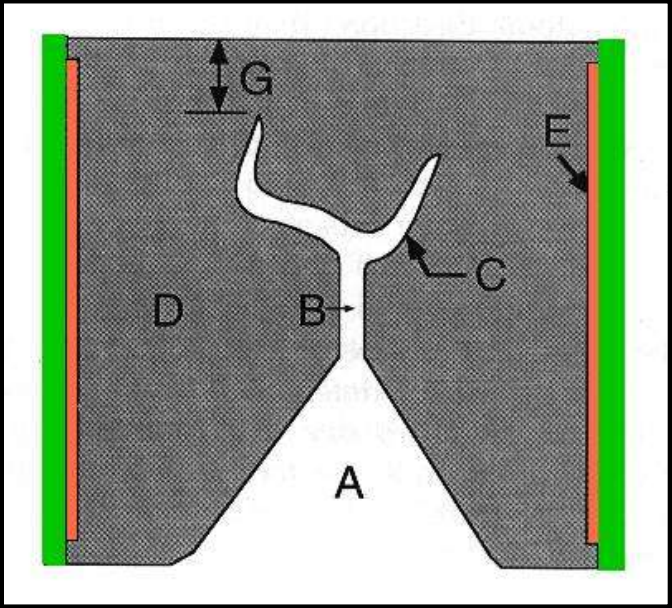
# Introduction

- When the wax pattern is to be reproduced in an alloy a mould is made in a material which will withstand the temperature at which these alloys melts.
- The procedure of making such a mould is called investing and the material used is the investment material.



# Metal Casting

- Lost wax technique (Taggart, 1907)




A ← crucible former
B ← sprue
C ← wax pattern
D ← investment material
E ← ring liner
G ← thickness of investment at the top

# Definition {GPT-8}

- Invest : to surround, envelop, or embed in an investment material.

- Investing : the process of covering or enveloping, wholly or in part, an object such as a denture, tooth, wax form, crown, etc. with a suitable investment material before processing, soldering, or casting

# Ideal requisites of investment

- Easily manipulated and capable of reproducing the size, shape and details recorded in the wax pattern.
- Sufficient strength at room temperature
- Stability at high temperature and must not decompose to give off gases that could damage the surface of alloy.

- It should have sufficient setting, hygroscropic, thermal expansion to compensate for the shrinkage of cast metal on cooling.

  Ease of divestment

- Should be inexpensive

# CLASSIFICATIONS

1 According to ANSI/ADA specification no -2 for casting investment for dental gold alloy encompasses three types of investments.

- Type-1
- Type-2
- Type-3

# TYPE- 1

- When the casting shrinkage is compensated by the thermal expansion of the investment.
- Used for inlays and crown.

# TYPE-2

- When the casting shrinkage of the metal is compensated by the hygroscopic expansion of the investment by immersing the investment ring in water bath.
- Also used for inlays, onlays and crown.

# TYPE-3

- Used in the construction of partial dentures with gold alloys.

## 2 Depending on the melting range of alloy and the type of binder

- Gypsum bonded- traditional type & used for conventional casting of gold alloy inlays , onlays and FPD's.
- Phosphate bonded – designed primarily for alloy to produce coping or framework for metal ceramic prosthesis and for some base metal alloys, also for some press able ceramics.
- Silicate bonded- used for casting of RPD's with base metal alloys.

# COMPOSITION

- In general, an investment is a mixture of 3 distinct types of materials.
  - Refractory(65%-75%)
  - Binder(25%-45%)
  - Other chemicals.(2%-15%)

# Refractory Material

- Usually in the form of silicondioxide such as Quartz, Tridimite, or Cristobalite or mixture of these.
- These are contained in all dental investment weather for casting gold or high melting point alloy.

# Binder

- They are used to hold the other ingredients together and to provide rigidity.
- Strength of investment depends on the amount of binder present.
- Ex:
  - Alpha $CaSo^4$ hemi hydrate (25-45%).
  - Phosphates
  - Ethyl silicate

# Other chemicals

- NaCl, Boric acid, $K^2So^4$, graphite, Cu powder or Mg o are often added in small quantities to modify various physical properties, such as boric acid and chlorides enhances thermal expansion of gypsum bonded investment.

# Gypsum-bonded investment


Bellavest T
160 g e


Samit
GYPSUM BONDED
CASTING INVESTMENT
SUPER FINE GRAIN
For Dental Golden Casting Alloy
SETTING TIME - 25 MINUTES
WT 1 Kg nett whe Packed
Mfd. By : Dento Kem, Farid

# Gypsum bonded investments (below 1000°C)

- Composition:
  - Silica is added as a *refractory component* to provide refractory during heating of investment and to regulate the thermal expansion.(55-75%)
  - *Binder*: Alpha $CaSO_4$ hemi hydrate.
  - *Modifying agent*: coloring agent and reducing agent like C / Cu powder. They produce non oxidizing atmosphere in the mould when gold alloy is cast.
  - *Additives*: boric acid and Nacl to regulate setting time and expansion, and to prevent shrinkage of gypsum when heated above 300° c

# Some properties of investments

1. Effect of temperature on refractory and binder.
2. Thermal expansion
3. Effect of cooling of investment.
4. Setting expansion and hygroscopic expansion and factors affecting it.
5. Role of water in hygroscopic expansion.
6. Porosity
7. Storage

# Effect of temperature on refractory and binder

- Investment is expected to expand thermally to compensate partially or totally for the casting shrinkage of gold alloy during heating.

- Gypsum shrinks considerably when it is heated. If proper form of silica are employed in the investment this contraction can be eliminated and changed to an expansion.

# Four allotrophic form of silica

- Quartz
- Tridimite
- Cristobalite
- Fused quarts.

- When these form of silica are heated ,a change in crystalline form occurs at transition temperature and they inwards

- from a low form, alpha form to a high form called beta form, and inversion to the lower alpha form occurs on cooling in each case.

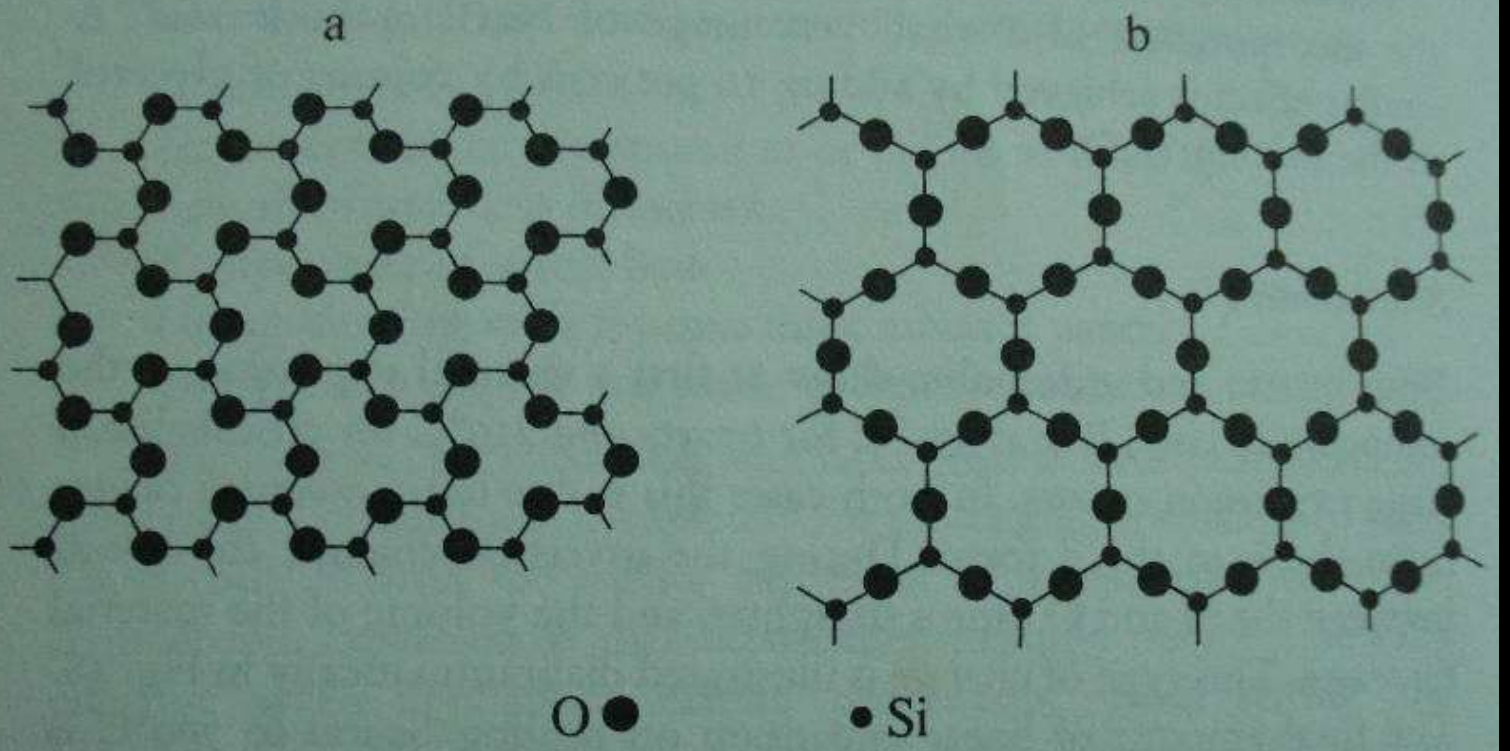



**Fig. 38.** Bond straightening at the inversion change from $\alpha$ to $\beta$ quartz. No bonds are broken. (a) Atom centres below 573°C. (b) Atom centres above this temperature

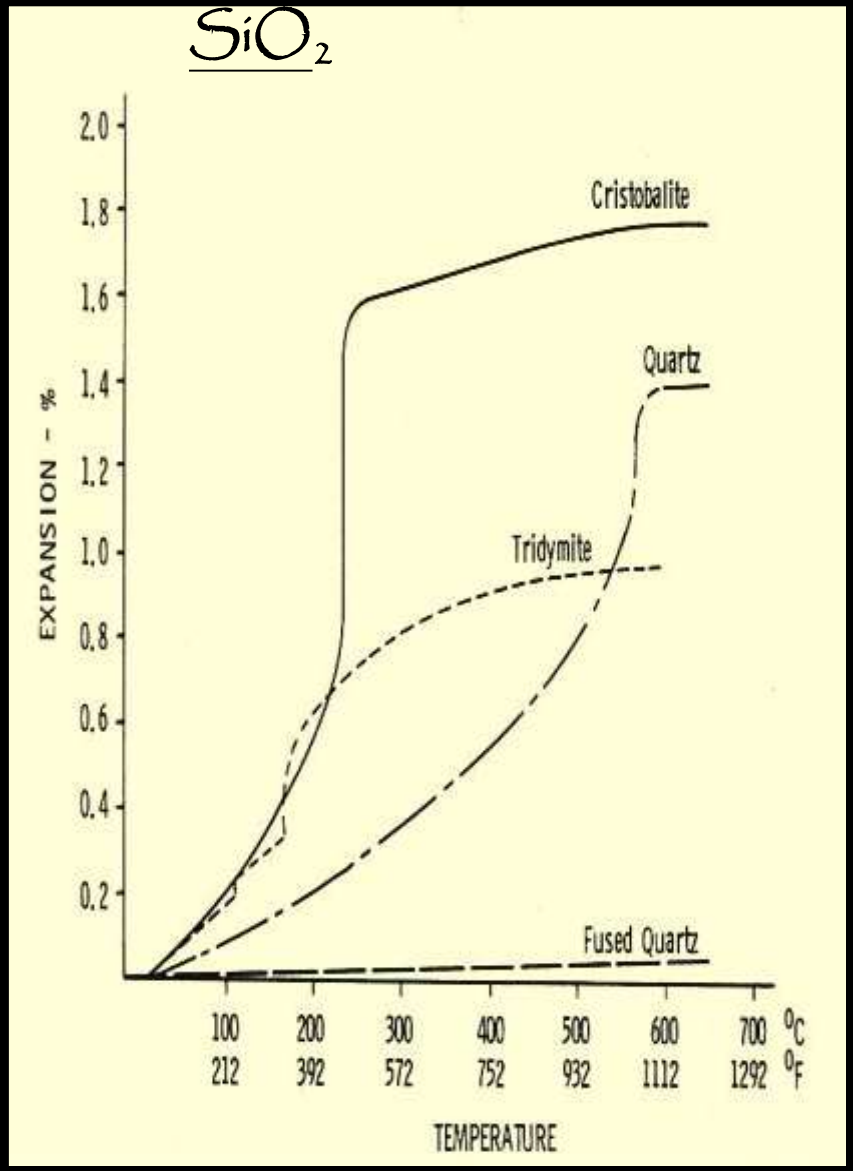
# Effect on binder

- It has been observed there is an expansion of the investment from room temperature to 220 F, beyond 220 F there will be contraction.

- At elevated temperature, alpha form of silica is converted to the beta form , and provide some additional expansion.

# Thermal Expansion (1.0-1.5%)

- Directly related to the amount of $SiO_2$ present and to the type of $SiO_2$ employed (quartz vs. crystobalite).
- The effect of $SiO_2$ will balance the contraction of the gypsum during heating.
- The maximum thermal expansion is attained at a temperature $\leq$ 700°C.



# Factors to Control Thermal Expansion

- Thinner mixed → less thermal expansion
- The sufficient amount of $SiO_2$ to prevent any contraction during heating can weaken the investment.
  - Chemical modifiers, e.g., sodium, potassium and lithium chlorides, are added to eliminates the contraction caused by the gypsum and increases the expansion without the presence of an excessive amount of $SiO_2$.

- Finer the size greater will be the expansion.
- Type of binder:
  - Alpha or Beta?

# Cooling of investment

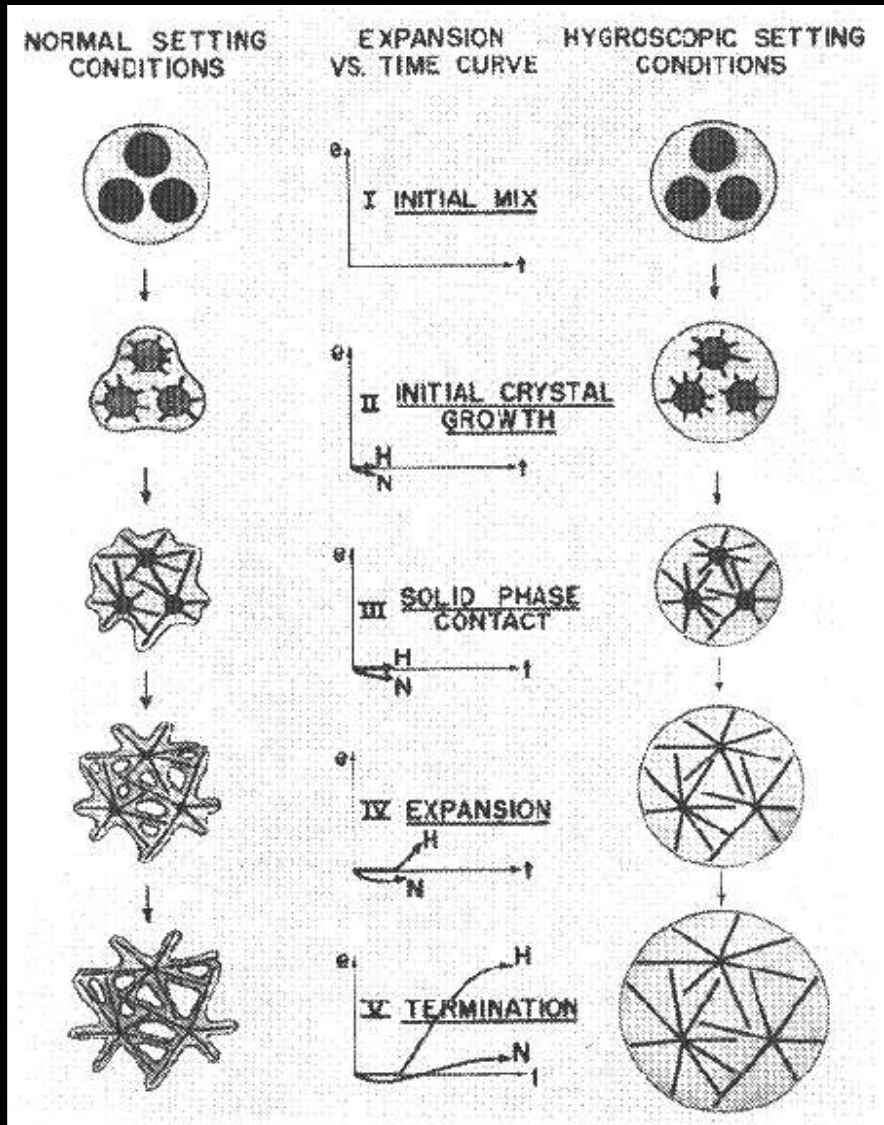
- As we have seen the conversion of alpha form of silica to the beta form of silica and the CaSo4 dihydrate to Anhydrous CaSo4, both of these changes involves some dimensional changes in the mould .

# Setting expansion and hygroscopic expansion

- Setting expansion is the linear expansion which takes place during the normal setting of the investment in air.
- Hygroscopic setting expansion is the linear expansion which takes place if the investment is in contact with water from any source during setting process.

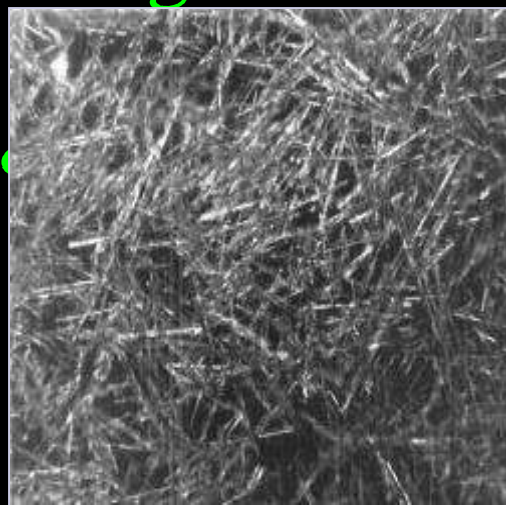
# Setting Expansion (normal vs. hygroscopic)

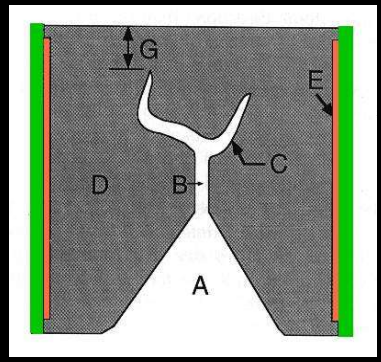
- Stage I: initial mix
- Stage II: crystals of dihydrate are formed
  - Lt: water around the particles is reduced by the hydration and the particles are drawn more closely together by the surface tension action of the water
  - Rt: hydrated water is replaced
- Stage III: crystals grow
  - Lt: water is decreased, particles are drawn together
  - Rt: water is replaced, crystals grow freely
- Stage IV and V



# Normal Setting Expansion (0.3-0.4%)

- Occurs from
  - $CaSO_4 \cdot 1/2H_2O \rightarrow CaSO_4 \cdot 2H_2O$
- A mixture of silica and gypsum hemihydrate results in setting expansion greater than that of the gypsum alone.
  - The silica particles probably interfere with the intermeshing and interlocking of the crystals as they form. The thrust of the crystals is outward during growth, and they increase expansion.
- Can be regulated by retarders and acc



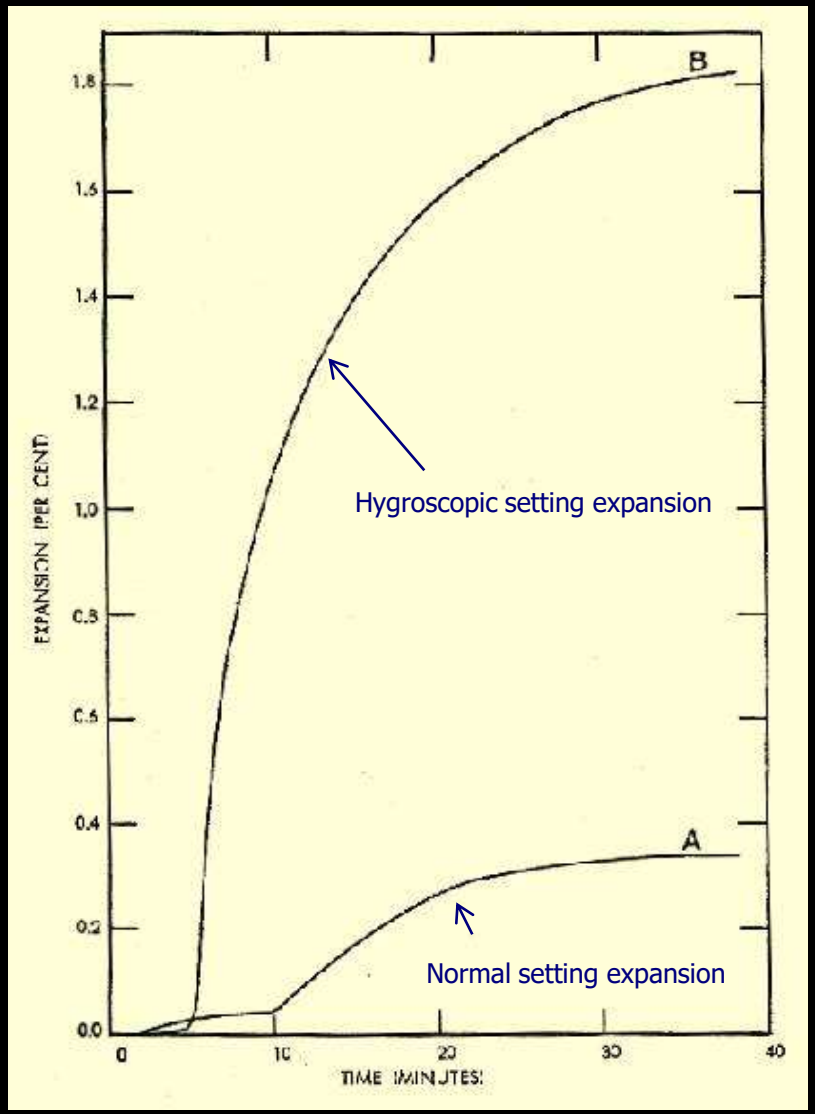



- As the investment sets, it eventually gains sufficient strength to produce a dimensional change in the wax pattern as setting expansion occurs.
- The softer wax is more easily moved by the expanding investment.

  →select appropriate material for a pattern

# Hygroscopic Setting Expansion

- Occurs when the gypsum product is allowed to set under or in contact with water
- Can be obtained from
  - Water immersion technique
  - Water added
  - Wet ring liner
- Greater magnitude than the normal setting expansion (≥ 6 times)



# Factors to Control Normal and Hygroscopic Setting Expansion

- Composition
  - Proportional to the $SiO_2$ content
  - The finer the particle size of the $SiO_2$, the greater the hygroscopic expansion.
- Water:Powder Ratio
  - Higher W:P → less expansion
- Spatulation
  - Insufficient spatulation → decrease expansion
- Shelf life of the investment
  - Older investment → lower expansion

- Time of Immersion
  - Delayed immersion → decrease expansion
- Confinement
  - the walls of the investment container, or the walls of a wax pattern
- Water bath / Amount of Added Water
  - The magnitude of the expansion is in direct proportion to the amount of water added during the setting period until a maximum expansion occurs.

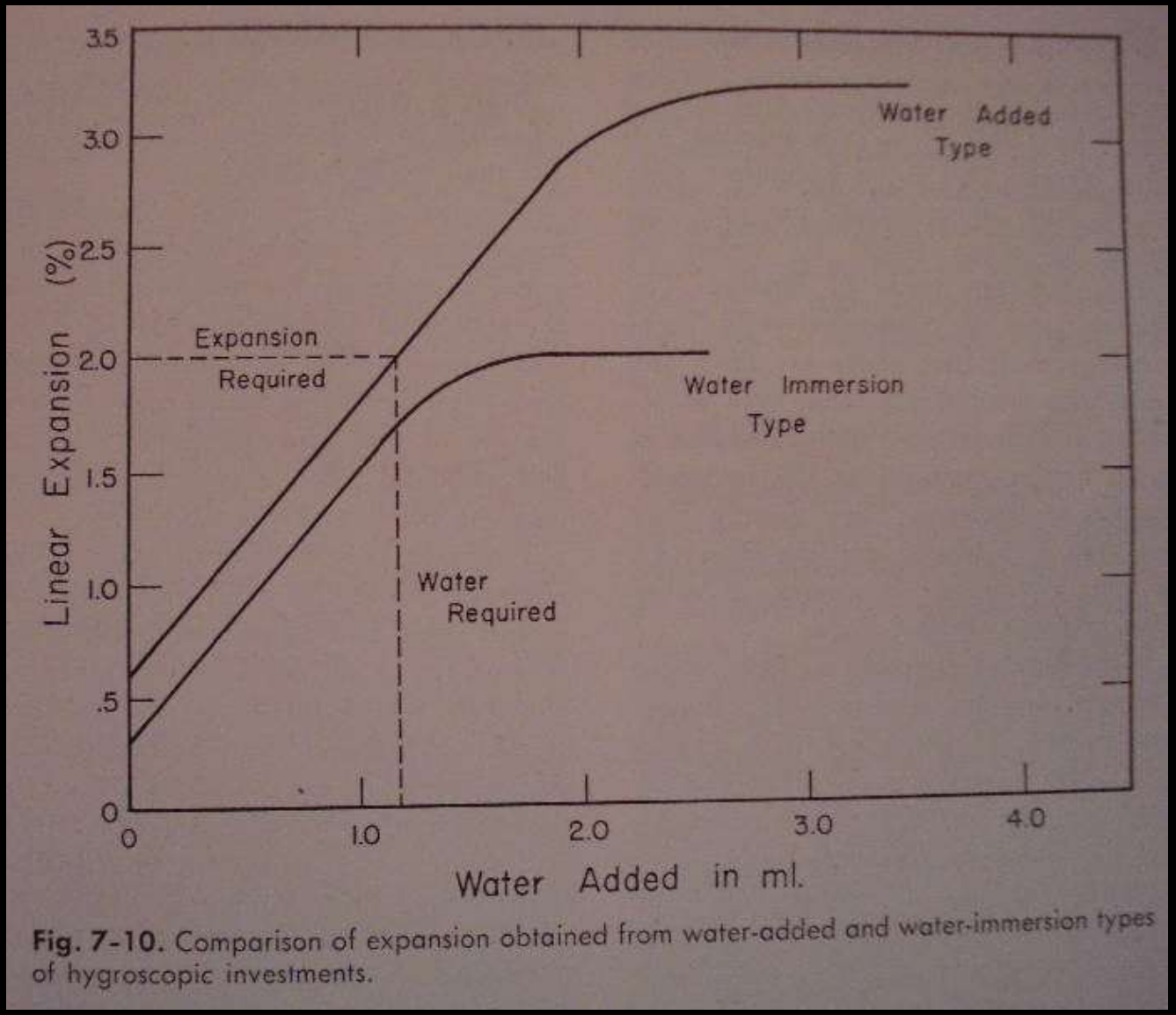
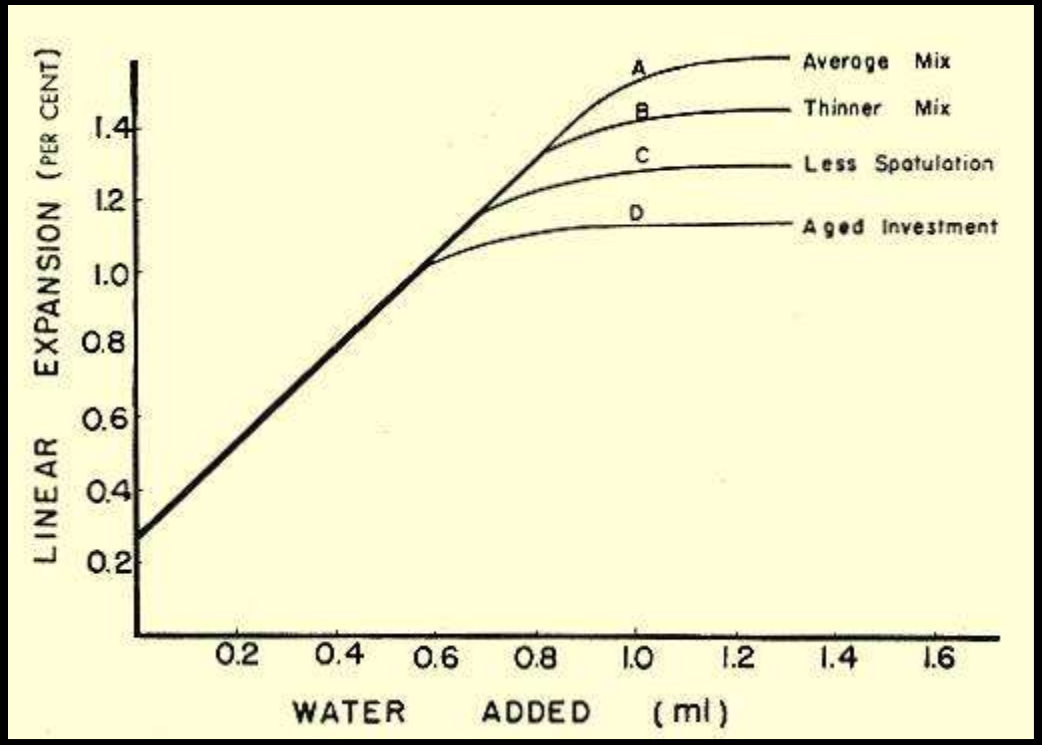



**Fig. 7-10.** Comparison of expansion obtained from water-added and water-immersion types of hygroscopic investments.

# Linear hygroscopic setting expansion vs. Amount of water added



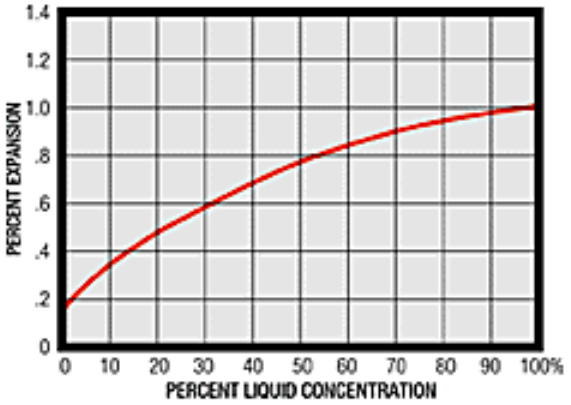
# Role of added water

- HSE is a continuation of normal setting expansion, bcz of the immersion water replaces the water of hydration thus preventing the confinement of growing crystals by the surface tension of excess water.

# Storage

- Under high relative humidity the setting time, HSE, SE may be altered. Therefore they should be stored in air tight or moisture proof container.
- All investment composed of diff ingredients with diff specific gravity and having tendency for these components to separate as they settle, according to their SG under normal vibration in lab.

# Phosphate-bonded investment


- The rapid growth in use of meta
hot pressed ceramic prosthesis h
in an increased use of phosphate or silicate bonded investments.
- They are used for metal ceramic prosthesis using high melting gold alloy and for base metal alloys. (above than 1300° C)
- Ex: AgPd, AgPt & NiCr.

# Composition

- Filler (refractory) = quartz or cristobalite or both (80%)
- Binder = magnesium oxide and acid phosphate
- Liquid = colloidal silica suspension


- Setting Reactions:
  - $NH_4H_2PO_4 + MgO \rightarrow NH_4MgPO_4 + H_2O$
  - The reaction is not simple and changed on heating.

# Setting and Thermal Expansion

- Increased expansion and strength is obtained by adding a combination of different silica particle size. (using a colloidal silica solution instead of water)
- Modified by
  - altering the liquid:powder ratio or
  - decreasing the concentration of the special liquid.

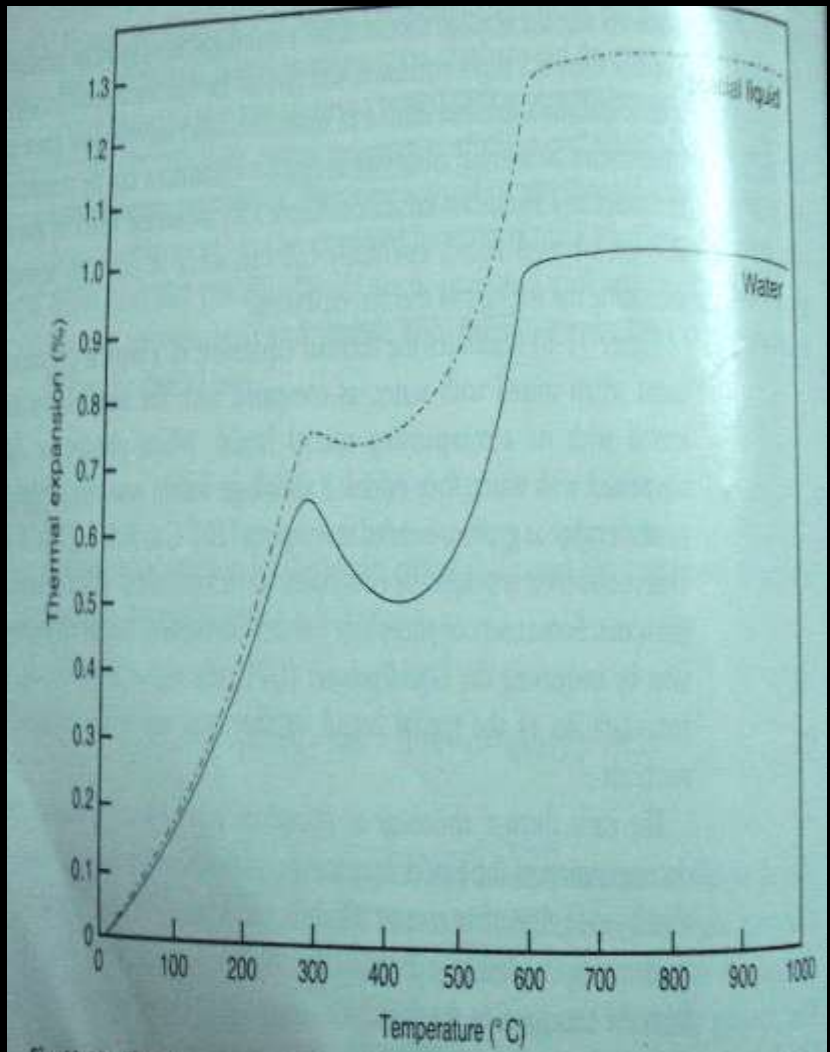



Fig. 12-10 Thermal expansion of a phosphate-bonded investment mixed with water as compared with the special liquid. (Courtesy of R. Neiman, Whip-Mix Corporation, Louisville, KY.)

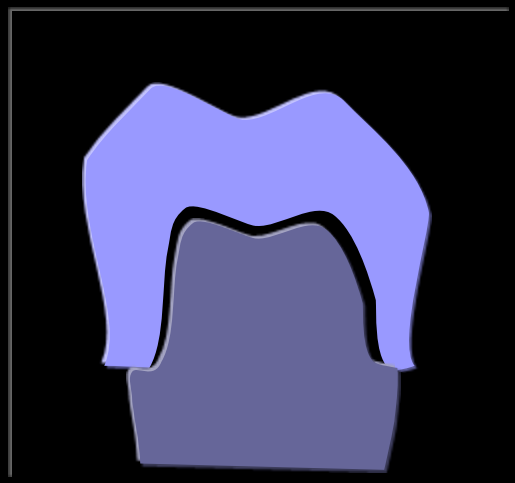
# Working and Setting Time

- Markedly affected by temperature
  - The warmer the mix, the faster it sets.
- Increased mixing time and mixing efficiency result in a faster set and a greater rise in temperature.
- In general, the more efficient the mixing, the better the casting in terms of smoothness and accuracy.
- Mechanical mixing under vacuum is preferred.


Vacuum Power Mixer Pro

# Other Properties

- Increasing the special liquid:water ratio used for the mix markedly enhances casting surface smoothness but can lead to oversized extracoronal castings.



# ADA Specification No.42

- Specifies two types of phosphate-bonded investments for alloys having a solidus temperature above 1080°C
  - Type I: For inlays, crowns, and other fixed restorations
  - Type II: For partial dentures and other cast, removable restorations

**Can also be used with alloys having casting temp. below 1080°C**

# Silica bonded investments

- These investments materials are used for casting alloys which have high casting temperature.
- They are used in the construction of the high fusing base metal partial denture alloy.
- This type of investment is losing popularity bcz of more complicated and time consuming procedures involved.

# composition

- These investments are mixture of powder and liquid.
- Powder consists of refractory particles of silica in various forms, plus MgO.
- Several liquids


The greatest friend of truth is
time, her greatest enemy is
prejudice, and her constant
companion humility
Thank you all