

Investment Materials

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Definitions:

Refractory material:

- It is a nonmetallic material that can withstand high temperature without degradation, softening or losing its strength.

Definitions:

Investment material:

- It is a ceramic material that is used for making a mold into which metal or alloy is cast. It can withstand high temperature so it can be called refractory material.

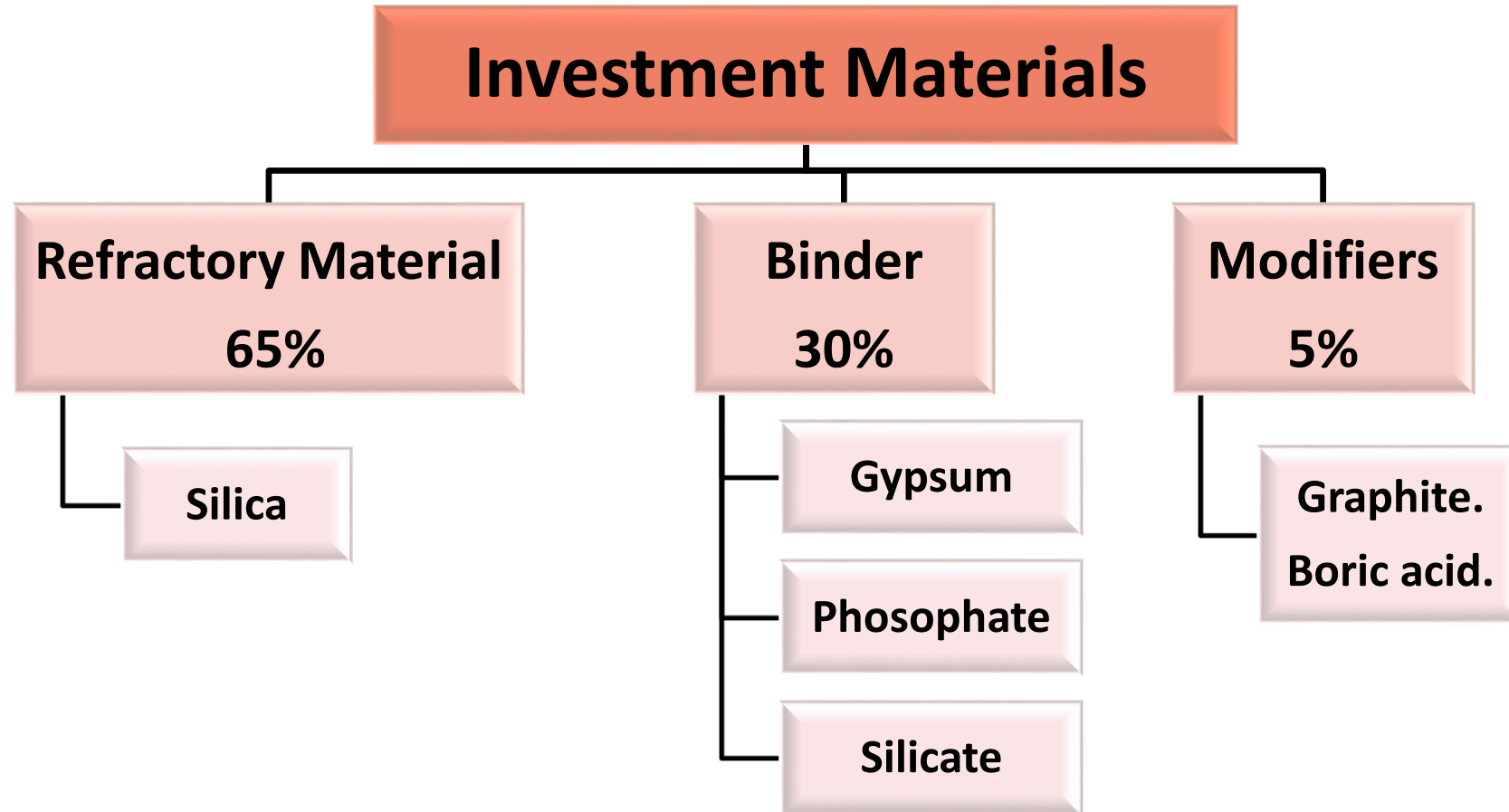
Ideal requirements of an investment material:

1. It should withstand **high temperature** during casting.
2. It should produce **sufficient expansion** to compensate solidification shrinkage.
3. It should have sufficient **strength** at room and high temperature.
4. It should be porous to allow **escapement of air** during casting.

Ideal requirements of an investment material:

5. It should produce **smooth surface** of the casting.
6. It should represent **fine details** of the casting.
7. It should **not react** with the metals or alloys during casting.
8. It should be **easily broken** after casting.
9. It should be **easily manipulated** and cheap.

Components of an investment material:



Components of an investment material:

1. Refractory material:

- The most used material is silica (silicon dioxide SiO₂).
- Silica has different polymorphic forms which showed thermal expansion upon heating.
- Function of refractory material:
 - a) It withstands high temperature.
 - b) It produces thermal expansion of the mold (displasive transformation from α to β form).

Components of an investment material:

2. **Binder:**

- It the material used for binding the investment material components.
- Investment materials are classified according to type of binder.

Components of an investment material:

2. **Binder:**

➤ **Function of the binder:**

- a) Binds investment components together.
- b) Provide strength to the mold.
- c) Gives hygroscopic and thermal expansion (in some types of investment).

Components of an investment material:

3. Modifiers:

- They modify the properties of the investment material such as:
 - a) prevent metal oxidation
 - b) produce smooth surface of the investment
 - c) prevent contraction of the binder.

Investment Materials

	Gypsum bonded investment	Phosphate bonded investment	Silicate bonded investment
Mode of supply	Powder + water	Powder + water Powder + silica sol	Powder + HCL + silica sol

Investment Materials

	Gypsum bonded investment	Phosphate bonded investment	Silicate bonded investment
Setting reaction	$\text{CaSO}_4 \cdot \frac{1}{2} \text{H}_2\text{O} + \text{H}_2\text{O} \longrightarrow \text{CaSO}_4 \cdot 2 \text{H}_2\text{O} + \text{Heat}$		

Investment Materials

	Gypsum bonded investment	Phosphate bonded investment	Silicate bonded investment
Setting reaction		Ammonium diphosphate + MgO → Magnesium ammonium phosphate	

Investment Materials

	Gypsum bonded investment	Phosphate bonded investment	Silicate bonded investment
Setting reaction			<p style="text-align: center;">HCL</p> <ul style="list-style-type: none">▪ Ethyl silicate + H₂O $\xrightarrow{\text{HCL}}$ Silicic acid sol + ethyl alcohol▪ Silica (powder) + silicic acid sol $\xrightarrow{\text{HCL}}$ polysilicic acid gel.

Investment Materials

	Gypsum bonded investment	Phosphate bonded investment	Silicate bonded investment
Binder	$\text{CaSO}_4 \cdot 2 \text{H}_2\text{O}$	Magnesium ammonium phosphate	Polysilicic acid gel

Investment Materials

	Gypsum bonded investment	Phosphate bonded investment	Silicate bonded investment
Setting expansion	Occurs	Occurs specially with using silica sol	No

Investment Materials

	Gypsum bonded investment	Phosphate bonded investment	Silicate bonded investment
Setting contraction	No	No	Occurs due to gelation of polysilicic acid sol by evaporation of alcohol

Investment Materials

	Gypsum bonded investment	Phosphate bonded investment	Silicate bonded investment
Hygroscopic expansion	Occurs if the gypsum allowed to set under water.	Occurs if silica sol is used	No

Investment Materials

	Gypsum bonded investment	Phosphate bonded investment	Silicate bonded investment
Thermal expansion	Occurs due to displasive transformation of silica from α to β form.		

Investment Materials

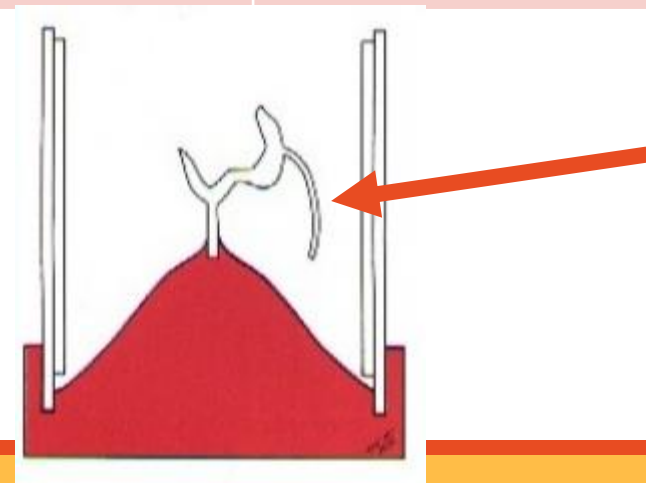
	Gypsum bonded investment	Phosphate bonded investment	Silicate bonded investment
Heating temperature	700 °C	1100 °C	1100 °C

Investment Materials

	Gypsum bonded investment	Phosphate bonded investment	Silicate bonded investment
Strength	Strong	Stronger	Strongest

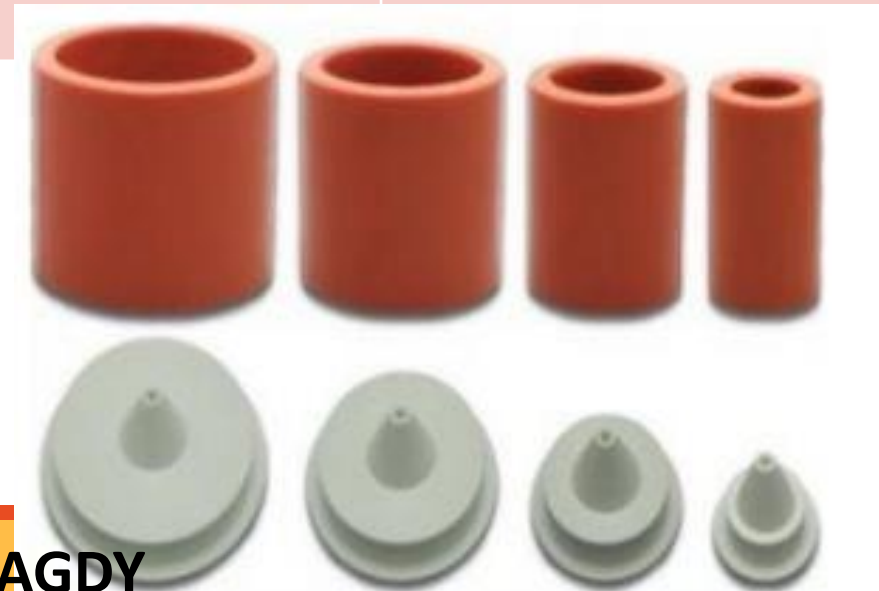
Investment Materials

	Gypsum bonded investment	Phosphate bonded investment	Silicate bonded investment
Porosity	Porous	Porous	Not porous. So venting is required.



Investment Materials

	Gypsum bonded investment	Phosphate bonded investment	Silicate bonded investment
Casting ring	Metallic ring	Rubber ring	Rubber ring



Investment Materials

	Gypsum bonded investment	Phosphate bonded investment	Silicate bonded investment
Total expansion	1.6%	1.6% (when mixed with water) 2.3% (when mixed with silica sol)	2.3%

Investment Materials

	Gypsum bonded investment	Phosphate bonded investment	Silicate bonded investment
Uses	Casting of gold alloy	<ul style="list-style-type: none">• Casting of gold alloys (when mixed with water)• Casting of base metal alloys (when mixed with silica sol)	Casting of base metal alloys

Thank You



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