Investment Material

A material which placed around the wax pattern and permitted to harden, to be, after wax elimination the mold into which the metal is centrifuged. When the wax pattern is to be reproduced in either gold or Cr-Co alloy, a mould is made in a material which is called investment material which withstand high temperature to which these alloys melt the carved wax pattern which is embedded in an investment material to form a mould within a sprue. The wax subsequently melted by heat or softening then the mold is ready to receive the molten metal by controlled heating in a furnace.

Factors affecting on the selection of investment:

The main factor affects the selection of an investment material is the casting temperature to be used and the type of alloy.

1. Gold alloy: casting temp =700Cº.

2. Metal- ceramic, chromium alloy: casting temp =850- 1100Cº.

The choice of suitable investment depends on the ability of the material to retain its integrity at the casting temperature also able to compensate the metal shrinkage.

Requirements of an ideal investment material:

1. Easy to use and reasonable setting time.
2. Sufficient strength at room and high temperatures.
3. Must not decompose at high temperature.
4. Should have enough expansion to compensate for shrinkage of wax and metal.
5. Should be porous to allow air and other gases to escape.
6. Should produce smooth surface and fine details.
7. Should be inexpensive.

Each type of investment should be composed of:

1. Refractory material like silicone dioxide (silica): material that will withstands very high temperature and regulate the thermal expansion, it is available in quartz, cristobalite, tridymite and fused quartz. These are chemically identical but differ in the crystalline form, the silica is responsible for the production of expansion to compensate the shrinkage of the alloy during casting, this expansion is called crystalline inversion and is due to straitening of the bonds between the silicon and the oxygen to form less dense crystals this expansion is greater in cristobalite than the quartz.
2. Binder which binds the refractory particles: the alpha calcium sulphate hemihydrate is the binder for gypsum-bonded investment, phosphate for phosphate-bonded investment & ethyl silicate for ethyl silicate-bonded investment.
3. Chemical modifiers to modify the physical properties: such as sodium chloride, boric acid, potassium sulfate.

Types of investment material:

1.Gypsum bonded investment: It is used to form mold for casting gold alloys for crown and bridges. It is supplied as a powder which is mixed with water, the powder composed of mixture of silica and calcium sulfate hemihydrate either plaster or stone other additives like graphic cupper sodium chloride and boric acid. The (CSH) reacts with water to form (CSD) which effectively binds the refractory silica particles. The magnitude of gypsum bonded investment hygroscopic expansion is greater than the gypsum mold. Three types of expansion may be developed: setting expansion (which is partially compensated of the alloy shrinkage during casting), thermal expansion & hygroscopic expansion (which can be achieved by immersion the mould in water during the initial setting); these types of expansions are about 1.3-2%. It will decompose to sulfur dioxide and sulfur trioxide when heated above 700Cº tending to embrittle the alloy; therefore it is not used for cobalt- chromium or palladium alloys. After 1200 Cº an interaction between the silica with the calcium sulfates to liberate sulfur trioxide gas that leads to the porosity of the cast and corrosion of the metal.

2.Phosphate bonded investment: It is used to form mold for casting high temperature dental alloys like co/cr, also used as fixture for holding dental appliance to be soldered or welded. It is supplied as powder and liquid. The powder is composed of silica magnesium dioxide (80%) and ammonium diacid phosphate (20%), liquid is composed of colloidal silica suspended in water. The powder is mixed with the liquid and poured around the wax pattern allowed to set around 30 minutes. After setting the material shows setting expansion just as gypsum bonded investment as a result of the outward thrust of the growing crystals the material also get hygroscopic expansion if immersed in H2O during setting. Using colloidal silica will also increase the setting expansion and the strength of the material. On heating from 1300-1500 Cº will break down the investment material resulting in a poor surface on casting.

3.Ethyl silicate bonded investment: It is used as phosphate bonded investment. This type is composed of silica dioxide in the form of quartz or cristobalite and magnesium oxide which are bounded together by the liquid where it is supplied as 2 or 3 liquid systems mixed to form solution of ethyl silicate and denaturized acid. Ethyl silicate has the disadvantage of containing inflammable components, so sodium silicate and colloidal silica are more commonly used as a binder. These investments are supplied with two bottles of special liquids. One bottle contains dilute water-soluble silicate solution such as ethyl silicate. The other bottle contains diluted acid solution such as hydrochloric acid. On heating the silica gel is turned into a mass of silica so the final mould is a tightly packed mass of silica particles. In this type gradation of the particles size is important. A very thick dry mixture is used and it is vibrated in order to encourage a close packing between the particles, this type of investment has sufficient strength at high temperature. Silica bonded investment shows a slight contraction during early setting and early heating due to the loss of water and alcohol form the material . A considerable expansion occurs later; due to the closed packed nature of the silica particles, thermal expansion is about 1.6%.