Elastomeric Impression Materials

They are liquid polymers which can be converted to solid rubber at room temperature. By mixing with a suitable catalyst they undergo polymerization and/or cross linking (by condensation or addition) reaction to produce firm elastic solid.

Terminology:

Polymerization: chemical reaction that transforms small molecules into large polymer chains.

Addition reaction: Polymerization reaction in which each polymer chain grows to maximum length in sequence and there is no by-product.

Condensation reaction: Polymerization reaction in which the polymer chains all grow simultaneously and by-product is formed.

Cross-linking: the reaction that links or joins polymer chain to form a network structure called a gel.

Catalyst: a component of reaction that facilitates the reaction and usually does not become part of the final product.

Accelerator: a component of the polymerization reaction that is similar to the catalyst but also speeds up the reaction.

Vulcanization: the process of heating natural rubber with sulfur to produce cross-linking.

Viscosity: is a property that controls the flow characteristic of materials.

There are three types of elastomers:

1. Polysulphide.
2. Silicone (condensation, addition).
3. Polyether.

Each type may be further divided into four viscosities:

A. Light body or syringe consistency.

B. Medium or regular body.

C. Heavy body or tray consistency.

D. Very heavy or putty consistency.

Polysulphide

This was the first elastomeric impression material to be introduced. It is also known as Mercaptan or Thiokol.

♦ **Application:** polysulphides are commonly used for crown and bridge and occasionally for dentures work.

♦ **Supplied as:** paste in collapsed tubes as base and accelerator.

Base: white colored.

Accelerator: brown or gray colored.

♦ **Available:** in three viscosities by controlling the filler in its composition:

~ Light bodied ~ Medium bodied ~ Heavy bodied

The higher the filler percentage the higher the viscosity and the less setting contraction, less thermal contraction and more dimensional stability.

♦ Composition:

"Base paste"

Component	Function
*Liquid polysulphide polymer with terminal &pendant thiol (-SH) groups	This is further polymerized and cross-linked to form rubber
*Inert filler (silica or titanium dioxide)	To give body, control viscosity & modify physical properties

"Catalyst paste"

Component	Function
*Lead dioxide	React with thiol groups causing setting
*Dibutyl phthalate	Plasticizer
*Sulfur	To enhance reaction
*Magnesium stearate	Retarder & deodorant

The lead dioxide react with the polysulphide polymer causing chain lengthening by oxidation of terminal –SH groups, and cross linking by oxidation of pendant –SH groups. The reaction is exothermic 3-4C°rise in temperature. It is accelerated by heat and moisture.

Mercaptan + Lead dioxide ⟶ Polysulphide + Water

♦ Manipulation:

Equal lengths of (2) tubes are mixed on a paper pad or glass slab with a stiff spatula until the(2) colors blend will together with no streak . Over-mixing has an effect on the elasticity it is used with a special tray, better adherence to the tray is achieved by using adhesive on the inner side of the tray the adhesive should be thin & dried first, pouring the cast should be within the 1st hour, S.T is about (12.5-16) minutes. Be careful of glove powder contamination of the impression.

♦ Properties:

1. Unpleasant odor and color, stains the cloths and messy to work with.
2. It has long setting time of 12.5 minutes.
3. Excellent reproduction of surface detail.
4. Dimensional stability is not good: the curing shrinkage is high 0.45% and continues even after setting, loss of the by-product (water) also causes shrinkage. It has the highest permanent deformation among the elastomers. This improves with time so pouring of the model should be delayed by half an hour; further delay is avoided to minimize curing shrinkage.
5. It has high tear strength, good flexibility, good shelf life and inexpensive to use.
6. It is hydrophobic so the mouth should be dried before making an impression.
7. Requires a custom tray which should be painted with thin layer of adhesive.

silicone rubber impression material:

There are two types of silicone rubber impression material based on the type of polymerization reaction occurring during its setting:

Condensation silicone **Addition silicone**

• Condensation silicone:

This was the earlier of the two silicone impression materials; available in three viscosities: light bodied, medium bodied & putty.

♣ Application:

Condensation silicone rubber impression materials are commonly used for crown and bridge and occasionally for partial denture.

♣ Supplied as:

1. Two pastes system for light & medium bodied: base & catalyst pastes.
2. Putty: supplied in a single large plastic jar, the same catalyst paste may be used or sometimes it may be supplied as liquid.

They come in variety of colors (contrasting colors aid mixing).

♣ Composition:

Base: Polydimethyl siloxane (hydroxyl terminated).
Inert filler colloidal silica or metal oxide filler 35-75% depending on viscosity.
Color pigments.

Catalyst: Orthoethyl silicate (cross-linking agent).
Stannous octoate (catalyst).

♣ Setting reaction:

It is a condensation reaction, polymerization occurs as a result of cross-linking between the orthoethyl silicate and the terminal hydroxyl group of the dimethyl siloxane to form a three dimensional network. Stannous octoate act as a catalyst. The reaction is exothermic 1Cº rise. Ethyl alcohol formed as by product evaporates gradually from the set rubber leading to shrinkage.

Dimethyl + Orthoethyl $\longrightarrow$ Silicone + Ethyl
siloxane silicate stannous octoate rubber alcohol

♣ Properties:

1. Pleasant color and odor, cleaner to handle than polysulphide.
2. Direct skin contact should be avoided to prevent any allergic reaction.
3. Setting time shorter than polysulphide 8-9 minutes.
4. Excellent reproduction of surface details, very good elastic property, elasticity develop earlier than polysulphide, but it is stiffer and harder than polysulphide.

5. Dimensional stability is comparatively less because of high curing shrinkage (0.4 -0.6 %) also due to evaporation of the ethyl alcohol by-product. Dimensional change is greater than that of polysulphide but less that of alginate. To avoid this cast should be poured immediately.
6. Adequate tear strength but it is lower than polysulphide.
7. It is hydrophobic; the impression field should be dried well before making an impression.
8. Shelf life is slightly less than polysulphide due to the usable nature of the orthoethyl silicate.
9. Slightly more expensive than polysulphide.
10. They are most widely used with stock tray (putty consistency) offering an advantage over polysulphide which is used with special tray only, the special tray needed to be painted with adhesive.

- **Addition silicone:**

It was introduced later. It has better properties than condensation silicone. It is also known as polyvinyl siloxane, available in four viscosities: light bodied, medium bodied, heavy bodied & putty.

◘ Supplied as:

1- Two pastes system: base and catalyst pastes come in equal size tube (unlike condensation silicones)

2- Putty jars: two equal size plastic jars, one containing the base and other the catalyst.

◘Composition:

Base: Polymethyl hydrogen siloxane, other siloxane prepolymers and fillers.

Catalyst: Divinyl poly siloxane, other siloxane prepolymers, Platinum salt as activator (catalyst, chloroplatinic acid), palladium or hydrogen absorber, retarders and fillers.

◘Chemical reaction

It is addition reaction in which silane (hydride group) of polymethyl hydrogen siloxane (base) is replaced by silane group of the other paste (catalyst), the reaction is activated by the platinum salt. Sulfur contamination from latex gloves retard the setting of silicones, vinyl gloves should be used, there is no by product.

Silane siloxane	+	Vinyl siloxane	→ chloroplatinic acid	Silicone rubber

◘Properties:

1. Pleasant odor and color.
2. Cause allergic reaction so direct skin contact should be avoided.
3. Excellent reproduction of surface details.
4. Setting time is 5-9 minutes.
5. It has the best dimensional stability among the elastomers even after one week. It has a low curing shrinkage 0.17% and the lowest permanent deformation 0.05-0.3%.
6. It has good tear strength.
7. It is hydrophilic, similar care should be taken while making the impression and pouring the wet stone.
8. It has low flexibility and harder than polysulphide, extra spacing 3mm should be provided in impression tray. Care also should be taken while removing the stone cast from the impression to avoid any breakage.
9. Shelf life ranges from 1-2 years.
10. More expensive.

◘Polyether:

It has good mechanical properties and dimensional stability. Its disadvantage is that it is very stiff material, short working time and expensive.

♠ **Supplied as:** base and accelerator in collapsible tubes. The accelerator tube is usually smaller. Earlier it was supplied in single viscosity. A third tube containing thinner was provided. Now it is available in three viscosities: light bodied, medium bodied & heavy bodied.

♠ Composition:

Base: Polyether polymer.
Colloidal silica (filler).
Glycolether or phthalate (plasticizer).

Accelerator: Aromatic suffonate (cross-linking agent).
Colloidal silica (filler).
Glycolether or phthalate (plasticizer).

♠ Setting reaction:

Polyether + Sulphonic ester ⟶ Cross-linked rubber

♠ Properties:

1. Pleasant odor and taste.
2. The sulphonic ester may cause skin reaction… direct skin contact should be avoided.
3. Setting time is around 8.3 minutes, the material is clean to handle.
4. Good dimensional stability under relatively low humidity; because the material is hydrophilic so humidity will cause swelling and distortion of the material when the humidity is high. Curing shrinkage is low 0.24%, permanent deformation is low. The material should not be stored in water or in humid climates.
5. It is extremely stiff. Its hardness is higher than polysulphides and increase with time. Removing it from undercuts is difficult, so extra spacing 4mm should be given. Care also should be taken while removing the cast from the impression to avoid any breakage.
6. Good tear strength, excellent reproduction of surface details and expensive**.**

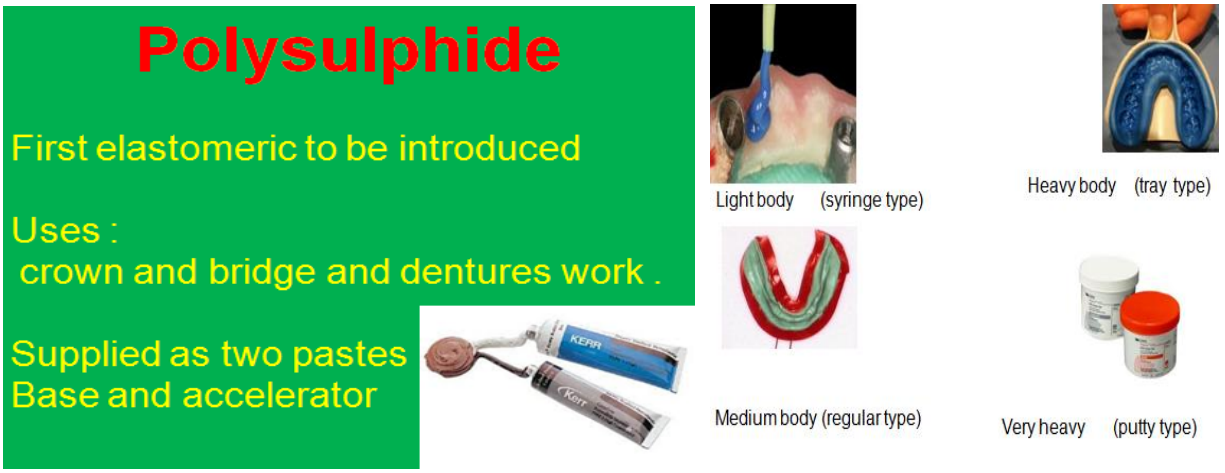
7. It is hydrophilic, so moisture in impression field is not so critical. It has the best compatibility with stone.
8. Excellent shelf life more than 2 years.

*** Technical considerations for rubber impression materials:

1. Impressions are usually made in special tray. Perforated stock trays are used only for making impressions in putty viscosity.
2. The spacing given is between 2-4mm.
3. Elastomers do not adhere well to the tray. An adhesive should be applied onto the tray and allowed to dry before making impression.
4. The bulk of the impression should be made with heavier consistency to reduce shrinkage. Light bodied should only be used in a thin layer as a wash impression.

*** Methods of making impression:

1. **Single mix technique:**
   Tray used: resin custom tray with 2-4mm spacing.
   Viscosity used: regular only.
2. **Multi mix technique:**
   Tray used: resin custom tray with 2-4mm spacing.
   Viscosity used: light bodied & heavy bodied.
3. **Two stage putty wash technique:**
   Tray used: perforated stock tray.
   Viscosity used: light bodied & putty.



Polysulfide Manipulation

- Adhesive to tray
- Uniform layer
  - custom tray
- Equal lengths of paste
- Mix thoroughly
  - within one minute
- Setting time 8 – 12 minutes
- Pour within 1 hour

Condensation Silicone Manipulation

- Mix thoroughly
  - paste - paste
  - paste - liquid
- Putty-wash technique
  - reduces effect of polymerization shrinkage
  - stock tray
    - putty placed
    - thin plastic sheet spacer
    - preliminary impression
      - intraoral custom tray
    - inject wash material

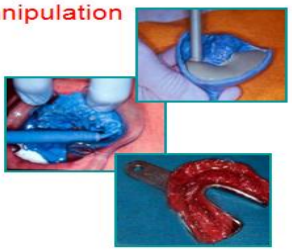
Addition Silicones

- Vinyl polysiloxane
- Indications
  - crown and bridge
  - denture
  - bite registration

Supplied as:
Paste tube
Equal size jars

Addition Silicones Manipulation

- Adhesive to tray
- Double mix
  - custom tray
    - heavy-body
  - light-body
- Putty-wash
  - stock tray



Polyether

- Indications
  - crown and bridge
  - bite registration

supplied as:
tow pastes system

Polyether Manipulation

- Adhesive to tray
  - stock or custom tray
    - very stiff
- Paste-paste mix
- Auto-mixing
  - hand-held
    - low viscosity
  - mechanical dispenser
    - high viscosity