Maxillofacial Prosthesis Materials

Acquired and congenital defects of the face create an unfortunate condition for the person to live comfortably and these persons need treatment using maxillofacial prosthesis.

Maxillofacial prosthetics is the branch of prosthodontics concerned with the restoration and/or replacement of the stomatognathic and craniofacial structures with the prosthesis .

Maxillofacial prosthetic materials are classified in two main groups: extraoral and intraoral prosthetic materials.

Extra oral prosthetic materials include vinyl chloride polymers, poly (methyl methacrylate), silicone, and polyurethane , these materials are used for facial prosthetics. At present silicones and polyurethane materials are considered most desirable for their strength, even though both are difficult to color.

Intraoral prosthetic materials include silicones, poly (methyl methacrylate), Tantalum, Vitallium, and Titanium mesh materials. Also silicone is particularly valued for its tissue tolerability. Metallic mesh materials have the advantage of permitting granulated tissue to migrate through the mesh.

Ideal Requisites for Maxillo-facial Materials:

1. Materials used should be biocompatible (not irritate the surrounding tissues, noncarcinogenic) .
2. Strength: it should be strong enough about the periphery to endure.
3. Flexibility: Should be flexible at temperatures from 4.4°C to 60°C.
4. Chemical and environmental stability (It should be resistant to various chemicals such as ether, oil and to sunlight, heat, and cold).
5. Thermal conductivity: Poor conductor of heat.
6. Ease of processing and ease of duplication.
7. Weight: Light and easily retained in position and be comfortable to the patient.
8. easy to sterilize.

Physical and mechanical properties are:

1. Tear strength: defined as the resistance of a material to tearing force and is important in thin sections such as the areas surrounding the nasal and eye prosthesis. The thin glued prosthesis is susceptible to tearing while removal, permanently damaging the prosthesis.

2. Ultimate Tensile Strength and Percent (Maximum) Elongation: the total percent elongation, which includes both the elastic and plastic elongation, is helpful as different parts of the face have different requirements in terms of stretching the elastomers to accommodate the facial movements. Thus it also gives us an idea about the flexibility of the material. Tensile strength is in the range 300 to 1,000 psi (2.0 to 7 MPa).

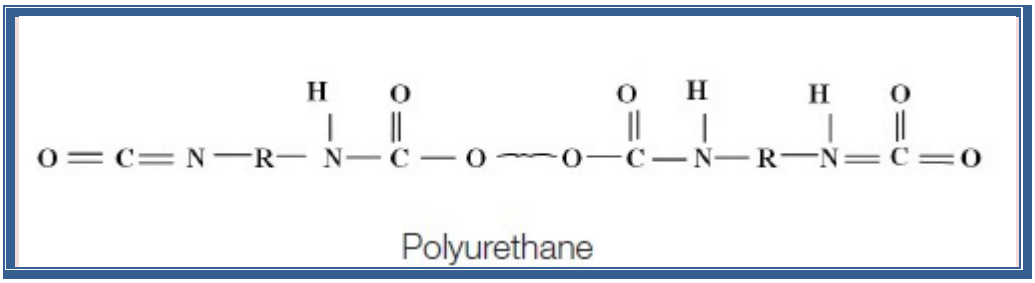
3. Hardness: defined as the resistance to abrasion and it is preferred that the prosthesis possess the same hardness as that of the missing facial structure.
4. Water Sorption: represents the amount of water adsorbed on the surface and into the body of the material during fabrication or whiles the restoration is in service. Prosthesis may absorb saliva, sweat or water while washing the prosthesis which may affect the physical properties including the color perception. The prostheses should not distort when boiled in water or sterilized in steam.
5. Weight: the materials should be light weighted so that they are comfortable for the patient and aids in the retention of the prosthesis.
6. The material should be dimensionally stable: when exposed to insults like sunlight, ultraviolet rays, and extreme conditions or to the adhesives and their solvents.

Materials
1. Acrylic resins: Polymethyl methacrylate was used before on the facial defects where the little movement occurs in the tissue bed during the function.

Advantages of the material are compatible with most of the adhesive systems; good strength, color stability, can be easily relined and repaired. Disadvantages: rigidity, discomfort.

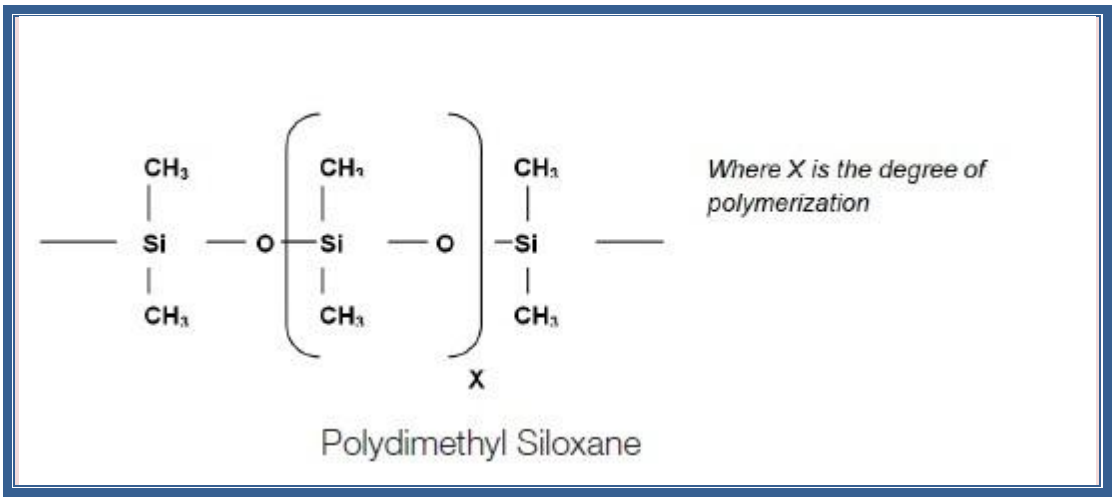
2. Polyvinylchloride and copolymers: Introduced in the mid1940s as plastisols. Most widely accepted are (polyvinyl chloride) and mediplas (polyvinyl acetate chloride), A clear, tasteless and odorless material and has been used widely for maxillofacial applications with advantages like being flexible, adaptable to both intrinsic and extrinsic staining. They are susceptible to the degradation or destruction by UV light, ozone, peroxide and they are relatively rigid and must be made flexible by the use of a plasticizer.

3. Polyurethane elastomer:



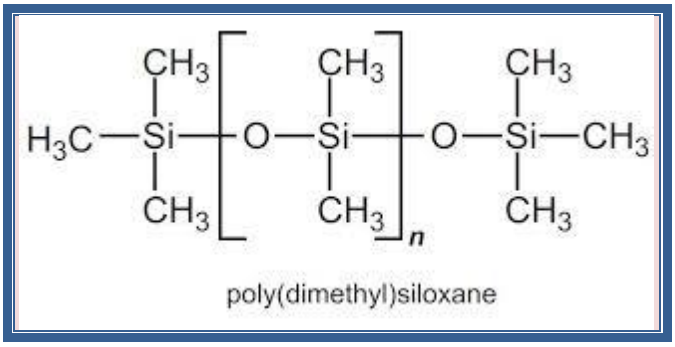
Advantages: These have good stability; higher tear resistance, low modulus without use of plasticizers, good ultimate strength and elongation. They can accept intrinsic coloration. Disadvantages include poor colour stability, poor compatibility with adhesive systems and moisture sensitivity leading to gas bubbles during processing and porous prosthesis. **Application,** used for maxillofacial prosthetics because these prosthesis require greater softness and flexibility.

4. Silicones: also known as polydimethyl siloxane is the most successful maxillofacial prosthetic material till now. These became more popular over other materials as they have a range of good physical properties (such as excellent tear and tensile strength) over a range of temperature, easier to manipulate, high degree of chemical inertness, low degree of toxicity, and high degree of thermal and chemical stability. Further they can be stained intrinsically and/or extrinsically to give them more lifelike natural appearance. With simple cleaning these materials are relatively safe. Silicone is a combination of organic and inorganic compounds and chemically they are termed as polydimethyl siloxane. The inorganic backbone makes the unique difference of this material as siloxane bonds Si—O—Si in the main chains, as well as Si—C bonds where side groups are bonded to silicone, are extremely flexible and have a great freedom of motion.



Polysiloxanes must be cross-linked to form solid elastomer materials. Depending whether the vulcanizing process uses heat or not, silicones are available as heat vulcanized (HTV) or room temperature vulcanized (RTV) and both exhibits advantages and disadvantages.

HTV silicone:



Heat-vulcanized silicones (High-temperature vulcanized - silicones) are used for maxillofacial prostheses. It is usually a white, opaque material with a highly viscous in consistency. It is available as one component or two component putty. Requires heat for vulcanization. Catalyst or vulcanizing agent is dichlorobenzoic acid (for condensation polymerization), platinum salts (for addition polymerization) (so no by product).. These silicones require advanced equipment for processing and have better physical properties. The processing temperature is 180°C- 220°C for about 30 min under pressure using metal molds.

Advantages:

1. Excellent tear strength and highest tensile strength at 5.87 MPa (polyurethane the lowest at 0.83 MPa.).

2. Excellent thermal, colour and chemical stability (rendering it more biologically inert).

3. High percent elongation.

Disadvantages:

1. Poor esthetics due to opacity.

2. Less elasticity.

3. Technique sensitive.

RTV silicone (Room temperature vulcanizing): Room-temperature-curing silicones are supplied as single-component materials that cure by evaporation of acetic acid. Prostheses are polymerized by bulk multiple packing. Recently epoxy resins and stainless steel molds are being used .

Advantages of the RTV silicone material: Use of stone molds, ease of manipulation and ease of colouring. Other advantages are colour stability and biological inertness.

The comparison of properties of HTV and RTV are summarized in the Table

Properties	HTV	RTV
Ultimate tensile strength (MPa)	5.87	4.20
Maximum Elongation (%)	441	445
Modulus (MPa)	4.66	2.12

RTV silicones are not as strong as the HTV silicones.
In comparison to other materials, both HTV and RTV have high tear resistance, because the samples do not tear but stretch, as in tensile elongation and high percent elongation ranging from 422% to 445%. Elastomers with a high dynamic modulus are rather rigid materials. RTV has the lowest dynamic modulus of 2.12 MPa .