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VINYL POLYETHER SILOXANE : REVOLUTIONIZING PRECISION IN ELASTOMERIC IMPRESSIONS

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Abstract

A precise impression is crucial for ensuring a perfect fit of indirect restorations. However, for many clinicians, obtaining an accurate impression for fixed prostheses remains one of the most challenging aspects of restorative dentistry, despite advances in elastomeric materials. The effectiveness of newly developed elastomeric polymer Vinyl Polyether Siloxane, which combines the properties of polyether and polyvinyl siloxane (PVS) elastomers, has been a subject of interest in recent studies. This review aims to elucidate the material properties of vinyl polyether siloxane through a comprehensive analysis of current scientific literature.

Keywords: vinyl polyether siloxane, polyether, polyvinyl siloxane, elastomeric impression materials, fixed prostheses

Introduction

An accurate impression is the first most important step in the procedure of obtaining a perfect restoration. It is the aim of the impression to produce a dimensionally stable 'negative' which can serve as a mold for a cast.[1]

The accuracy of impression materials is crucial for producing a well-fitting definitive restoration, relying on both dimensional stability and detailed reproduction. Various factors affect the dimensional accuracy, including periodontal health, oral hygiene, technique, tray selection, and material properties. Additionally, the material's ability to flow and conform to oral tissues, as well as its capacity to properly wet moist surfaces, plays a key role in achieving a precise impression. Any inaccuracies during this process can lead to errors when transferring information to the dental laboratory, ultimately compromising the fit and adaptation of the final restoration.[2]

Among available elastomeric materials, the vinyl polysiloxanes (VPS) and polyethers (PEs) are used most frequently.[3] Traditional additional silicones were hydrophobic; due to which accuracy of impressions was questionable. The newer ones have added surfactants to counteract this. Polyether, on the other hand, is hydrophilic and records good detail, but it is the stiffest among all elastomers.[1]

Combining Polyether (PE) with Polyvinyl Siloxane (PVS) to create hybrid materials offers several mechanical advantages. Due to the similar mechanical properties of both materials, this combination can enhance tensile and tear strength. The synergistic effect may improve performance in dental impressions, where flexibility and durability are essential.[4] This newer elastomer that has been developed is called as vinyl polyether siloxane (VPES) combining features of both addition silicone and polyether were commercially introduced in 2009 as stated. This new elastomer boasts of immediate hydrophilicity, at the same time combining favorable characteristics of both polyether and vinyl polysiloxane.[1] This article aims to explore new impression material that are both effective and efficient in achieving predictable, accurate, and high-quality impressions in dental practice.

History of Elastomers

In the 1950s, polysulfides and condensation reaction silicones (C-type silicones) were reliably used in fixed prosthodontics. In the late 1960s, polyether, a hydrophilic material cured by cationic ring-opening polymerization, was introduced. With its excellent mechanical properties, good elastic recovery, and minimal shrinkage, polyether outperformed hydrocolloids and C-type materials. A decade later, hydrophobic addition-cured silicones, or poly(vinyl siloxane) (PVS), were introduced, with their hydrophobicity reduced by adding surfactants. PVS is renowned for its high dimensional stability across time and temperature, as well as its superior elastic recovery, even in moist environments. According to Christensen in 1997, "The past 20 years have brought significant improvements in both polyether and PVS categories, making them the most widely accepted materials for prosthodontic applications." By 1997, the three dominant categories of impression materials for fixed, removable, and implant prosthodontics were addition reaction silicones, polyether, and reversible hydrocolloid, in that order of usage.[1] A novel impression material, Vinyl Polyether Siloxane (VPES), has recently been developed through extensive research and testing of various properties. This innovative hybrid combines the hydrophilic characteristics of polyether with the dimensional stability and elastic recovery of polyvinyl siloxane (PVS), resulting in a material that offers superior flow, tear strength, and accuracy in moist environments without the need for surfactants.

Chemistry of Vinyl Polyether Siloxane

It is a new chemical compound developed by combining polyether polymer and vinyl groups of VPS as shown in the figures below.[1]

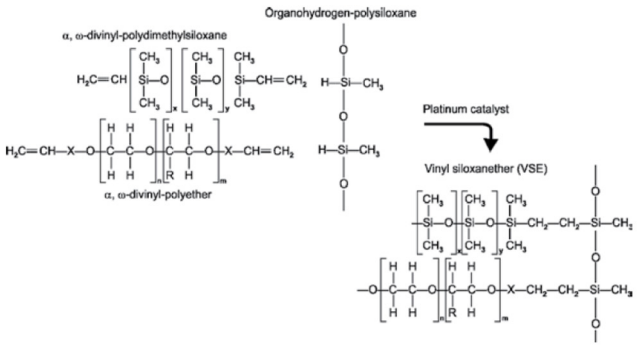
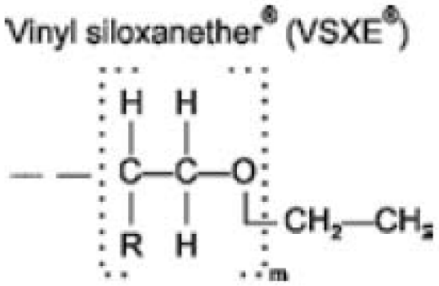


Figure showing Vinyl polyether siloxane molecule below:[1]



The properties of vinyl polyether siloxane (VPES) material and comparisons between VPES, addition silicone and polyether are summarized in Tables 1 and 2.[1]

Indications

The Vinyl Polyether Siloxane (VPES) impression material is designed exclusively for the one-step multiple-mix technique, ensuring optimal results in dental impressions. This technique involves the use of a custom tray and the simultaneous application of two viscosities: heavy body and light body materials. The heavy body is placed in the tray, while the light body is injected around the prepared tooth to capture fine details. The combination of these viscosities allows for accurate tissue recording and a precise fit for definitive restorations.

Some of the specific indications according to viscosity are listed below.[1]

Medium Viscosity

1. Transfer (implantology)
2. Crown and Bridge
3. Inlay/only
4. Veneer
5. Functional impression

Heavy Viscosity

1. Carrier (tray) product
2. Crown and bridge
3. Inlay/onlay
4. Veneer
5. Implant impressions.

Table 1: Summarizes the comparative properties of the various consistencies of VPES material

	Medium	*Medium soft*	*Heavy*	*Light*
Working time (35°C)	1 min 20 sec	1 min 20 sec	1 min 20 sec	1 min 20 sec
Intraoral setting time (35°C)	3 min 30 sec	3 min 30 sec	3 min 30 sec	3 min 30 sec
Total setting time	5 min 30 sec	5 min 30 sec	5 min 30 sec	5 min 30 sec
Hardness (Shore)	≈ A 60	≈ A 50	≈ A 60	≈ A 48
Linear dim. change	≈ –0.2%	≈ –0.2%	≈ –0.2%	≈ –0.2%
Recovery from deformation	≥99%	≥99%	≥99%	≥99%
Strain-in-compression	≈ 2.3%	≈ 3.3%	≈ 2.8%	≈ 3.5%

Table 2: Comparative properties

Property	*Addition silicone*	*Polyether*	*Vinyl polysiloxane ether*
Working time	2-4 min	3	1 min 20 sec
Setting time	4-6.5	6	5 min 30 sec
Automatic mixing	Y	Y	Y
Custom tray	N	N	N
Multiple casts	Y	Y	Y
Dimensional stability	–0.15%	–0.2%	≈ –0.2%

Light Viscosity

1. Precision impressions
2. Crown and bridge
3. Inlay/onlay
4. Veneer
5. Implant impressions.

Advantages

- Offer precise dimensional accuracy and excellent elastic recovery, ensuring accurate reproduction of dental structures and facilitating easy removal from the oral cavity.
- Remarkable hydrophilicity means an optimal wetting in a moist environment and the
- lowest achievable contact angle (less than 10° after 1 second).[8]
- Balanced setting behavior with the double-snap effect for a long working time at a short intraoral time.
- It allows the operator to either pour the cast immediately or disinfect the impression and send it to the laboratory for pouring at a later time, while maintaining the same level of accuracy.
- Excellent flowability due to a thermosensitive rheology system allows the material to get into the narrowest sulcus crevices while ensuring high stability.[9]
- Easy and fast, true-to-detail fabrication of casts without fracture risk.
- It is odorless and tasteless, hence accounts for a pleasant feel in the mouth. This ensures there is no gag reflex, no erratic movement on part of the patient.
- It is compatible with commercially available disinfectants.[1]

Properties

Dimensional Stability

Stober et al evaluated a study on the Accuracy of newly formulated fast-setting elastomeric impression materials and stated that vinyl siloxanether monophase impressions and vinyl siloxanether dual-viscosity impressions display acceptable accuracy for clinical use with immersion disinfection, since the results for vinyl siloxanether were comparable to the results for representative polyether and vinyl polysiloxane materials.[10]

Techkouhie A et al conducted a study on Surface detail reproduction of elastomeric impression materials related to rheological properties suggest that PVS has the smallest change (−0.15%), followed by polyether (−0.2%). The vinyl siloxane ethers have a dimensional change of ≈ –0.2% which is acceptable.[11]

Nassar U et al evaluated the dimensional stability of vinyl polyether silicone (VPES) impressions as a function of delayed-pouring time for up to 2 weeks after performing a recommended clinical disinfection procedure. It was concluded that the Casts produced from a disinfected regular set VPES (EXA'lence 370 monophase) demonstrated excellent dimensional stability at different pour times and were comparable to the tested VPS and PE impression materials.[5]

Surface detail reproduction

Rabeeba PK et al compared and evaluated the surface detail reproduction and effect of disinfectant and long-term storage for 2 weeks on the dimensional stability of hybrid material Vinyl polyether silicone (VPES) with its parent Polyvinyl siloxane (PVS) and Polyether (PE) impression materials and the results concluded that the newer material VPES was observed to

be both dimensionally stable and capable of producing good surface detail reproduction.[2]

Tear strength

Tear strength is influenced by the chemical composition, consistency, and manner of removal of material. A rapid rate of force application during removal usually increases the tear strength. Pandey P et al evaluated a study on Mechanical Properties of a New Vinyl Polyether Silicone in Comparison to Vinyl Polysiloxane and Polyether Elastomeric Impression Materials and the results indicated that the tear strength of vinyl polyether siloxane was better than polyether and vinylpoly siloxane.[3]

Tensile strength

Pandey P et al evaluated a study on Mechanical Properties of a New Vinyl Polyether Silicone in Comparison to Vinyl Polysiloxane and Polyether Elastomeric Impression Materials and the results indicated that the new vinyl polyether silicone had better tensile strength than polyether.[3]

Flexibility

Vinyl polyether siloxane tested was found to be more flexible with high tensile energy in a study evaluated by Pandey P et al. This material can be preferred in cases with undercut areas favoring the removal of impressions without tear and distortion.[3]

Effect of Disinfectant

Rabeeba PK et al compared and evaluated the surface detail reproduction and effect of disinfectant and long-term storage for 2 weeks on the dimensional stability of hybrid material Vinyl polyether silicone (VPES) with its parent Polyvinyl siloxane (PVS) and Polyether (PE) impression materials. According to the disinfection guidelines, it is suggested that addition silicone impressions can be disinfected by immersion without affecting its accuracy and surface detail reproduction. Surface detail reproduction is observed to be enhanced by the use of 2% acidic glutaraldehyde solution. In the present study all the impressions were disinfected in 2.45% glutaraldehyde solution for a duration of 30 minutes whereas the non-disinfected ones were kept in distilled water for 30 minutes. Among the disinfected groups Vinyl polyether silicone showed the least dimensional changes on 0 day, 7 days and 14 days of storage compared to polyvinylsiloxane and Polyether.[2]

Hydrophilicity

The hydrophilic or wettable characteristics of impression materials also contribute to passively fitting impressions. The hydrophilicity was measured by determiningthe contact angle of a drop of water on the material under observation. Singer et al. reported that PVES demonstrates improved hydrophilicity and wettability compared to PE and PVS, and these observations were also consistent with other studies.[4] Heuttiget al. reported the highest hydrophilicity of PVES, with a mean contact angle of 16.8° among eight samples.[12]

Surface quality

Rabeeba PK et al. conducted a clinical comparison of quality of vinyl polyether silicone impressions with polyvinyl siloxane impressions using one-step impression technique and the results showed that the new hybrid material vinyl polyether silicone displayed accepatable surface quality and handling properties for clinical use using one-step impression technique.[6]

Conclusion

Vinyl polyether siloxane represents the dawn of the next generation of materials, overcoming the drawbacks of all previous impression materials. This systematic review provides a

clear understanding of the properties of novel vinyl polyether siloxane hybrid impression materials. Vinyl polyether siloxane has significantly better tensile strength and provides impressions with fewer defects compared to polyether and Polyvinylsiloxane. Vinyl polyether siloxane exhibited better wettability and contact angle with water than Polyvinyl siloxane and Polyether. This makes it an excellent alternative to Polyvinylsiloxane, in which moist conditions are prevalent in the clinical setting. This makes vinyl polyether siloxane the preferred material for dental impressions. It can be concluded that vinyl polyether siloxane hybrid elastomers eliminate the drawbacks of Polyether and Polyvinylsiloxane, providing a novel impression material with superior tensile strength, hydrophilicity, and dimensional accuracy in one place. It is also worth noting that vinyl polyether siloxane exhibits satisfactory elastic recovery and detailed reproduction, as individual studies indicate. However, further researches can be done for a more detailed analysis of all the properties.

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