3M ESPE

Technical Product Profile

Express™ 2

VPS Impression Materials

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Introduction

3M ESPE is the worldwide market leader in impression materials and is renowned for its continuous innovations in this market segment. Since the introduction of the first impression material more than 40 years ago, 3M ESPE has continuously improved and enlarged its portfolio of polyether and VPS Impression Materials to serve virtually all customer needs and their indications, techniques and delivery choices.

With Express™ 2 from 3M ESPE the next generation of innovative VPS Impression Materials products is now available to dental professionals. The new products set the stage for uncompromising impression accuracy and quality, the prerequisite for excellently fitting restorations.

The Express 2 VPS line offers impression materials designed for the 1-step and the 2-step impression technique. The new products come in a variety of viscosities – ranging from putty to ultra-light body. All Express 2 Tray Materials can be mixed automatically in the Pentamix™ Automatic Mixing Unit – even those who prefer a putty consistency can benefit from the advantages the Pentamix System offers.

Express 2 products offer all the features a state-of-the-art precision impression material needs to precisely capture the preparation margins. Express 2 wash products are very hydrophilic and offer excellent flowability to tooth and gingiva while still retaining sufficient drip resistance.
Furthermore, when developing Express 2 special focus was paid to minimize the risk of tearing and distortions upon mouth removal – both are a potential source of poor fitting restorations. Express 2 products have a high stretching potential and a high tensile strength for greater toughness to resist tearing and recover nearly 100 % after stretching and compression.

These features make Express 2 VPS an ideal impression material with an outstanding combination of clinically relevant properties among leading brands – providing the ideal foundation for obtaining precise impressions and less potential for tearings and distortions upon mouth removal. Express 2 VPS products thus offer the best potential for accurately fitting restorations – saving valuable time for dentist, dental technician and increasing the patient comfort.

History

History of Precision Impression Materials

The first impression methods using wax, plaster and zinc oxide eugenol pastes were succeeded by true precision impression materials some 80 years ago (1925) with the introduction of hydrocolloids (see Fig. 1). Today hydrocolloids are still used to some extent when taking precision impressions although their popularity is in decline. On the other hand, the polysulphides, which were introduced 25 years later (1950), have almost lost their importance for precision impressions nowadays.

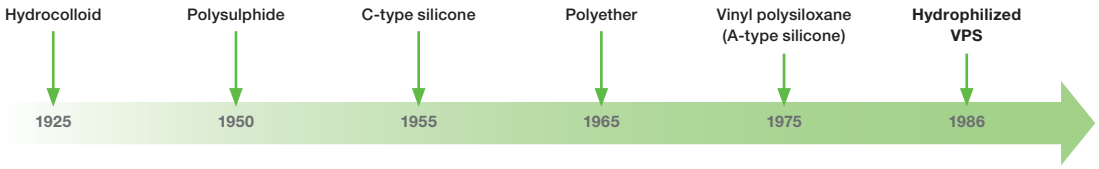


Fig. 1 History of precision impression materials

In the mid 1950s a class of material that was not originally intended for intra-oral use made its appearance in the world of dentistry: C-silicones (condensation-cured). The main disadvantages of these products were, and still are, their intrinsic shrinkage as condensation-curing involves the release of a volatile by-product, and their hydrophobicity.

A decade later in 1965 the polyether was introduced by ESPE. This is an addition-cured intrinsic hydrophilic impression material that is vastly superior to hydrocolloids and C-silicones in terms of its mechanical properties (e.g. tear strength). Furthermore, 3M ESPE polyether involves virtually no shrinkage as an addition-curing mechanism does not release any volatile by-products, and it is well established due to its first-class hydrophilicity.

Another 10 years later in 1975, the first vinyl polysiloxanes (VPS) were used as impression materials. As these materials are addition-cured, volatile by-products are no longer released. However, they were still hydrophobic due to their chemical nature. It was only in 1986 that it became possible to reduce the hydrophobicity intrinsic to the material's molecular structure. The addition of hydrophilizers (surfactants) results in an increase in hydrophilicity of the mixed material with time. Both, the development of more effective surfactants and the possibility to increase their concentrations in the VPS formulations led to an increase in VPS wettability in the last years.

Development of Automatic Application Systems for 3M ESPE Impression Materials

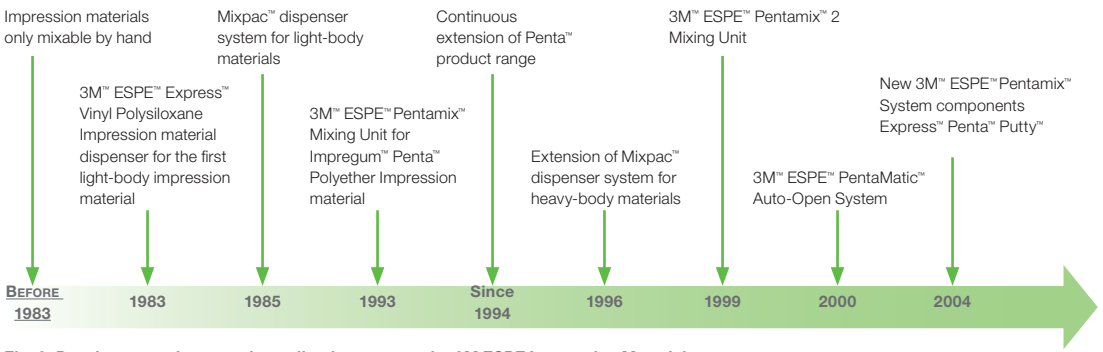


Fig. 2: Development of automatic application systems for 3M ESPE Impression Materials

The world's first application system for the automatic mixing of impression materials was launched by 3M (today 3M ESPE) in 1983 in the form of the 3M™ ESPE™ Express™ Dispenser for the first Express™ light-body material (Fig. 2). Two years later in 1985, this was followed by the Mixpac™ dispenser system (produced by ConProTec, Inc.), which provided for the automatic mixing of other light-body materials.

With the launch of the Pentamix™ System in 1993, ESPE set a further milestone in the history of automatic mixing systems, bringing about a lasting change in the impression procedure at the dental office. The development of Penta™ products started with Impregum™ Penta™ Polyether Impression Material. In the following years the Penta product range was continuously extended.

In 1996 the Mixpac™ Dispenser System was extended to include heavy-body materials. 1999 saw the introduction of the 3M™ ESPE™ Pentamix™ 2 Automatic Mixing Unit, catering for the wish of many practitioners for a faster unit. A year later in 2000, this was followed by the launch of the PentaMatic™ System, an automatic opening mechanism for the foil bags.

The introduction of three new Pentamix System components in 2004 has allowed the Penta product range to be expanded to include the putty material segment. Express™ Penta™ Putty is the first 3M ESPE putty available for the Pentamix device. It has been launched in Europe in September 2004.

Motivation

There are several reasons why a final restoration does not fit when inserted into the patient's mouth. The precision impression is ascribed a key role in this respect – it has to provide an exact copy of the intra-oral situation under any clinical conditions. The still large number of poorly fitting restorations shows that this key requirement for clinical success often is not met.

In order to make impression taking more reliable, developments on VPS impression materials in recent years mainly focused on the improvement of two parameters:

- an increase in hydrophilicity
- an increase in tear-strength

Clinically, improved hydrophilicity results in better wettability of the tooth surfaces, and performance in a moist environment. High tear strength reduces the risk that the impression material tears off upon mouth removal.

Another essential aspect for clinical success, however, has not always been considered sufficiently in these recent developments:
The impression material has to withstand all the forces (mainly stretching and compression) it is exposed to upon removal from the mouth. Otherwise the impression will experience a permanent deformation, a so called distortion. Distortions can be the reason for poorly fitting resorations. They usually are not known until the final restoration is ready for seating.

When developing Express™ 2 VPS Impression Materials, therefore, special focus has been put on creating a material that is less prone to distortions. This has been achieved by a new chemical formulation including a new network former (UCS = Unsaturated CarboSilanes) enabling a strongly increased crosslinking density. The result is an elastomer with a special property profile, which includes:

Features:	**Clinical Benefits:**
• high stretching potential	▸ allows the set impression to be removed from the sulcus, undercuts, and interproximal spaces
• high toughness: the ability to absorb a high amount of energy before tearing	▸ strongly reduces the risk of tear-offs
• > 99,5 % recovery after stretching and compression forces	▸ prevents permanent deformation (distortion)

The new Express 2 VPS Impression Materials offer all the other important features state-of-the-art precision impression material have, very high hydrophilicity and excellent flow characteristics.

All these Features taken Together make Express 2 an Impression Material with an Outstanding Combination of Clinically Relevant Properties.

With Express™ 2 Penta™ Putty VPS Impression Materials, dentists who prefer to use putty silicones for precision impressioning can take advantage of the benefits of the Pentamix™ Automatic Mixing Unit. Due to their very high viscosity, these materials have been typically mixed by hand, incurring the associated disadvantages such as non-homogeneity, contamination and the presence of voids in the mix. In response to the customer's desire for a longer working time, especially for the 1-step impression technique, Express 2 Penta Putty now offers a somewhat longer working time compared to its predecessor Express Penta Putty.

Indications

All precision impressions, e.g.:

- crown
- bridge
- inlay and onlay preparations.

The quick setting products are especially suited for single-unit and two-unit impressions.

Express™ 2 VPS Impression Materials at a Glance

Portfolio Overview

Product	Dispensing System	Viscosity Low – High	Setting version	Working Time at 23°C min:sec	Intra-oral Setting Time min:sec
TRAY MATERIALS					
Express™ 2 Penta™ Putty		Putty	Regular Set	1:30	3:00
Express™ 2 Penta™ H		Heavy Body	Regular Set	2:00	3:30
Express™ 2 Penta™ H Universal Quick		Heavy Body	Fast Set	1:30	2:30
Express™ 2 Penta™ H Quick		Heavy Body	Fast Set	1:15	2:30
WASH MATERIALS					
Express™ 2 Ultra-Light Body Quick			Fast Set	1:30	2:30
Express™ 2 Light Body *Flow*			Regular Set	2:00	3:30
Express™ 2 Light Body *Flow* Quick			Fast Set	1:30	2:30
Express™ 2 Light Body *Standard*			Regular Set	2:00	3:30
Express™ 2 Light Body *Standard* Quick			Fast Set	1:30	2:30
Express™ 2 Regular Body			Regular Set	2:00	3:30
Express™ 2 Regular Body Quick			Fast Set	1:30	2:30

Overview per Technique

Impression Technique	Color Tray Material	VPS Impression Materials Tray & Wash Material Combinations per Technique	Dispensing System
Express™ 2 Penta™ Putty ▸ real putty consistency			
2-Step Technique		Express™ 2 Ultra-Light Body Quick ▸ generates very thin layers	
1-Step Technique		Express™ 2 Regular Body ▸ stays very well at tooth	
Express™ 2 Penta™ H ▸ hydrophilic heavy body **2 choices:**			
1-Step Technique		Express™ 2 Light Body *Flow* ▸ offers great flow	
		Express™ 2 Light Body *Standard* ▸ stays very well at tooth	
Express™ 2 Penta™ H Universal Quick ▸ heavy body with excellent carving properties			
2-Step Technique		Express™ 2 Light Body *Flow* Quick ▸ offers great flow	
1-Step Technique		Express™ 2 Light Body *Standard* Quick ▸ stays very well at tooth	
Express™ 2 Penta™ H Quick ▸ hydrophilic heavy body **2 choices:**			
1-Step Technique		Express™ 2 Light Body *Flow* Quick ▸ offers great flow	
		Express™ 2 Light Body *Standard* Quick ▸ stays very well at tooth	

Product Composition

Components

The following tables provide an overview of the qualitative composition of the Express™ 2 Penta™ Putty, Express™ 2 Penta™ H Tray Material, and Express™ 2 Wash Materials.

Express™ 2 Penta™ Putty:

Base	Catalyst
Silane treated quartz silica	Silicate fillers
Vinyl polydimethylsiloxane	Vinyl polydimethylsiloxane
White mineral oil	White mineral oil
Dimethyl (methyl hydrogen) polysiloxane	Platinum catalyst
Pigments	

Express™ 2 Penta™ H (Heavy Body) Materials:

Base	Catalyst
Silane treated quartz silica	Silicate fillers
Vinyl polydimethylsiloxane	Vinyl polydimethylsiloxane
Dimethyl (methyl hydrogen) polysiloxane	Poly(methylsiloxane)
Poly(methylsiloxane)	Silane treated silica
Silane treated silica	Platinum catalyst
Pigments	Pigments
Polyethylene glycol, siloxane terminated	

Express™ 2 Wash Materials:

Base	Catalyst
Vinyl polydimethylsiloxane	Quartz silica
Quartz silica	Vinyl polydimethylsiloxane
Dimethyl (methyl hydrogen) polysiloxane	Silane treated silica
Silane treated silica	Pigments
Polyethylene glycol, siloxane terminated	Platinum catalyst
	Unsaturated Carbosilane Crosslinker (UCS)

Material Science Background

Express™ 2 VPS Impression Materials – product characteristics

Setting reaction

All Express 2 Impression Materials are pure addition-cured silicones (vinylpolysiloxanes, VPS). The setting reaction which cures the material involves platinum-catalyzed hydrosilylation (Fig. 3). Here hydrogen polysiloxanes are added to the double bonds of vinylpolysiloxanes under the catalytic influence of traces of a platinum compound in the ppm range.

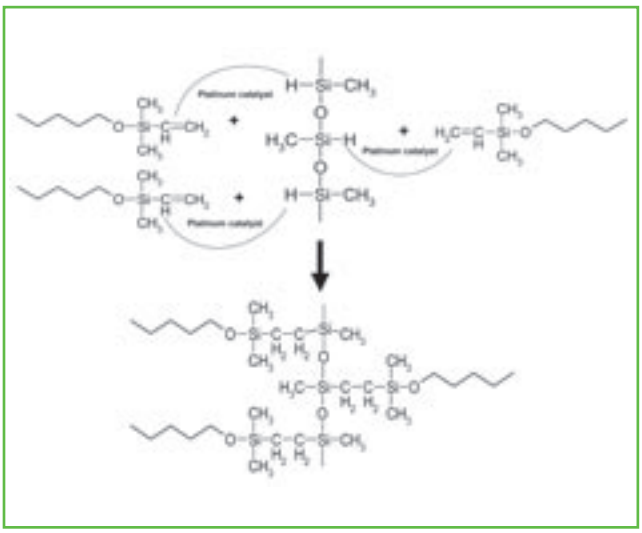


Fig. 3: Setting reaction of addition-cured silicones

In chemical terms this reaction is purely an addition reaction in which no by-products whatsoever are released. As a result there are no volatile by-products to cause shrinkage of the elastomer, something that is seen for example in the case of condensation-cured silicones. The high dimensional stability is one of the benefits of VPS materials.

Express™ 2 Penta™ Putty – a real putty material

Chemical matrix

Express 2 Penta Putty is a purely addition-cured silicone (VPS) consisting of

- a combination of vinyl polysiloxanes of varying chain lengths
- a combination of different hydrogen polysiloxanes
- a platinum catalyst
- a combination of fillers on a silicone dioxide basis
- a combination of plasticizers

Fig. 4: Mixing of Express™ 2 Penta™ Putty™ with the Pentamix™ 2 Mixing Unit

The mixing of a real putty consistency in the Pentamix™ Automatic Mixing Unit (Fig. 4) could only be realized by a unique combination of reactive polysiloxanes and fillers that is new to putties. This is an innovative way to rheologically enable the use of such high-viscosity pastes in the Pentamix Unit, without having to forfeit any of the customary putty characteristics. The innovative polymer combinations reduce the forces on the Pentamix Mixing Unit. From the customer's viewpoint, however, the usual high putty consistency is retained.

Like its predecessor Express™ Penta™ Putty the new Express™ 2 Penta™ Putty VPS Impression Material offers a true putty viscosity. The putty-like insertion pressure for Express Penta Putty has been demonstrated in a 3M ESPE internal test using a newly designed test apparatus which measures the resistance presented by a mixed paste to penetration by a test specimen. Fig. 5 shows that the insertion resistance (pressure) of Express Penta Putty corresponds to that of typical handmix putties and is much higher than the insertion pressure of heavy body VPS tray materials. Further confirmation for the putty-like insertion pressure for Express Penta Putty comes from an external study by Prof. Wöstmann, Justus-Liebig-University Giessen, Germany (unpublished data).

Express 2 Penta Putty thus provides dentists with the usual feel upon insertion of the impression tray that is so characteristic of putties.

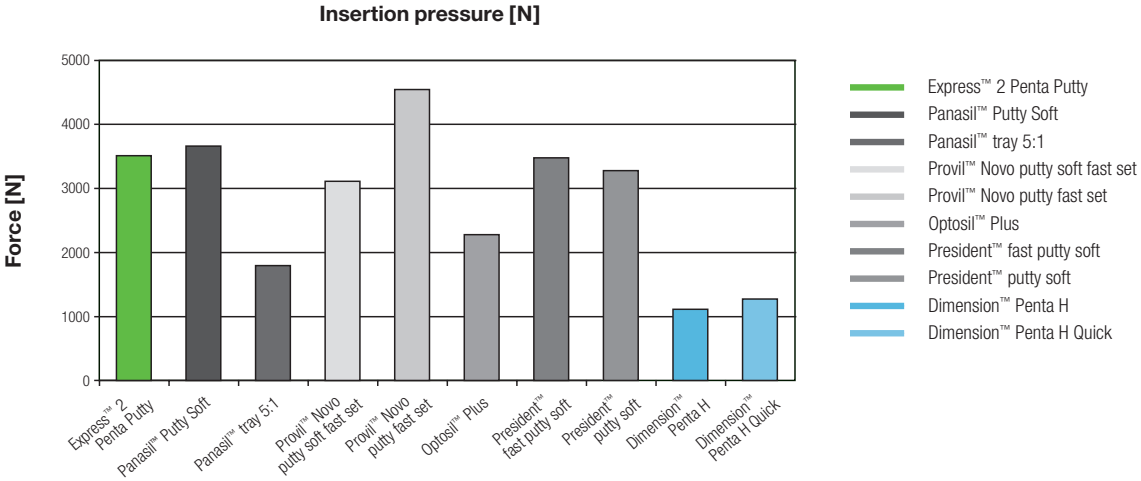


Fig. 5: Insertion pressure of various impression materials (mainly putty, blue colored colums; heavy bodied materials as comparison).

Source: I. Wagner et al, Insertion forces of conventional and new automixed putty impression materials, Joint Meeting of the Continental European, Israeli and Scandinavian Divisions of the IADR (August 25 – 28, 2004, Istanbul, # 140), and internal data.

The property profile of Express 2 Penta Putty has been realized by a combination of vinyl polysiloxanes of different chain lengths. Long-chain vinyl polysiloxanes increase the viscosity and result in the high putty consistency. The addition of short-chain vinyl polysiloxanes on the other hand leads to its very high final rigidity and thus a good carving of the impression material as well as fast intraoral setting.

The automatic mixing of Express 2 Penta Putty in the Pentamix™ Mixing Unit ensures homogeneous mixing quality despite a high paste viscosity. This results in a mixing quality which is largely free from streaks and voids in a manner that is typical of materials mixed in the Pentamix. Fig. 6 compares the cut surfaces of Express 2 Penta Putty (test specimen on left) and a hand-kneaded specimen of Express Standard Putty (test specimen on right).

Fig. 6. Superior mixing quality of Express™ 2 Penta™ Putty with the Pentamix™ Mixing Unit (left) compared with a putty mixed by hand (right, Express STD Putty).

Every setting reaction is susceptible to fluctuations in dosing, i.e. unintentional variations in the ratios between the base and catalyst. In practice this may often result in major changes in the setting time. Such effects are largely eliminated by the automatic dispensing of Express Penta Putty Impression Material in a constant volume ratio. Consistent dosing of the base paste and catalyst enables uniform setting behavior over the entire foil bag. The following figure shows the influence of overdosing/underdosing of the catalyst on the setting time of the mixed material in the case of a condensation-cured hand-kneadable putty silicone. As one can see in Fig. 7, underdosing by 25% doubles the setting time.

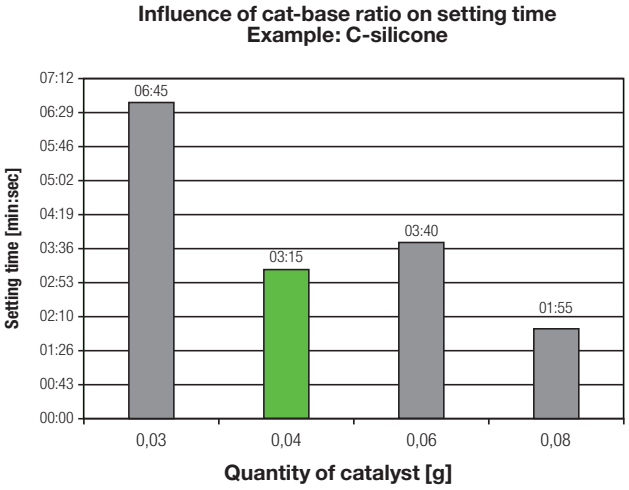


Fig. 7: Effect of overdosing/underdosing of catalyst on a standard condensation-cured putty silicone (0.04 g = exact proportion).

Thermally active properties:

In contrast to other tray impression materials Express™ 2 Penta™ Putty offers a unique benefit: It accelerates the intra-oral setting time of any VPS Wash Material combined with it for the 1-step impression technique. This thermally active behaviour results from the fact that Express 2 Penta Putty exits the Pentamix™ 2 Mixing Unit at about mouth temperature. As the putty is already warm when the tray is seated in the mouth, the wash material warms up faster than with other impression materials. Polymerisation of the VPS Wash Material – which is strongly temperature dependent – is accelerated. As a consequence, the intra-oral wash setting time is shortened, whereas its working time remains unchanged.

This is demonstrated in Fig. 8 in which the intra-oral setting time of Express™ 2 Light Body is compared when combined with Express 2 Penta Putty (thermally active) and Express 2 Penta Heavy Body (not thermally active). With Express 2 Penta Putty as tray material the intra-oral setting time for Express 2 Light Body is reduced by half a minute.

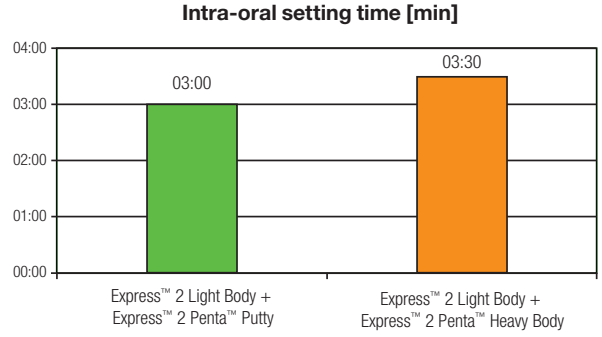


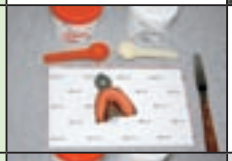
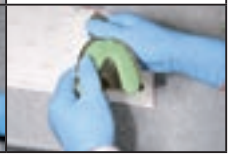
Fig. 8: Comparison of intra-oral setting time of Express™ 2 Light Body wash material when combined with Express™ 2 Penta™ Putty and Express™ 2 Penta™ Heavy Body. When combined with the thermally active Express™ 2 Penta™ Putty the intra-oral setting time for the wash material is reduced by half a minute.

Express™ 2 Penta™ Putty VPS Impression Material is designed to be used with regular setting wash materials and combines the clinical benefit of having a long wash syringing time (1 minute intra-oral) with the increased productivity and patient comfort from faster mouth removal of the impression.

Benefits of Express™ 2 Penta™ Putty VPS Impression Material

Material properties	Pentamix™ 2 Mixing Unit delivery
Customary putty like consistency and insertion force when seating tray	Standardized, consistently homogeneous mixing quality as well as absence of streaks and voids
High final rigidity	Hygiene and cleanliness of mixing process
Easy carving of initial impression for 2-step technique	Precise dosing
Thermally active properties	Long-term storage of pastes due to hermetic air seal in extremely airtight foil bags

Comparison of Handmix and Pentamix™ Procedures

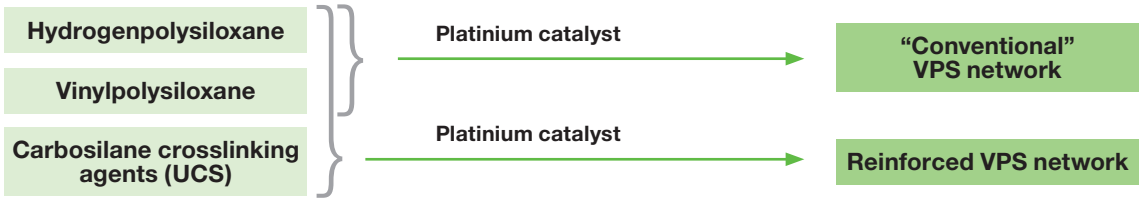
Procedures	Handmix-Procedure Express™ STD	Pentamix™-Procedure Express™ 2 Penta™ Putty
Preparation		
Material required		
Dosing		
Dosing of putty base material		n/a
Dosing of putty catalyst		n/a
Dosed putty material (base and catalyst on mixing pad)		n/a
Mixing		
Taking up dosed materials		n/a
Starting mixing of base and catalyst		n/a
Mixing (kneading)		n/a
Base and catalyst paste mixed		n/a
Filling the tray		
Preparation of Pentamix™ Mixing Unit – Attachment of red Penta™ Mixing Tip	n/a	
Even filling on impression tray by pressing button	n/a	
Ronning and subsequent insertion of mixed material into impression tray		n/a Optional:
Even distribution (n/a with Express™ 2 Penta™ Putty VPS Impression Material) and shaping material in the impression tray with finger		

Express™ 2 VPS Wash Materials

The special characteristics of the Express™ 2 Wash Materials have primarily been achieved by the development of a new network former. This substance, which in chemical terms belongs to the class of siloxane resin-free unsaturated carbosilanes (UCS = Unsaturated CarboSilane) crosslinker, is new to addition-cured silicone impression materials.

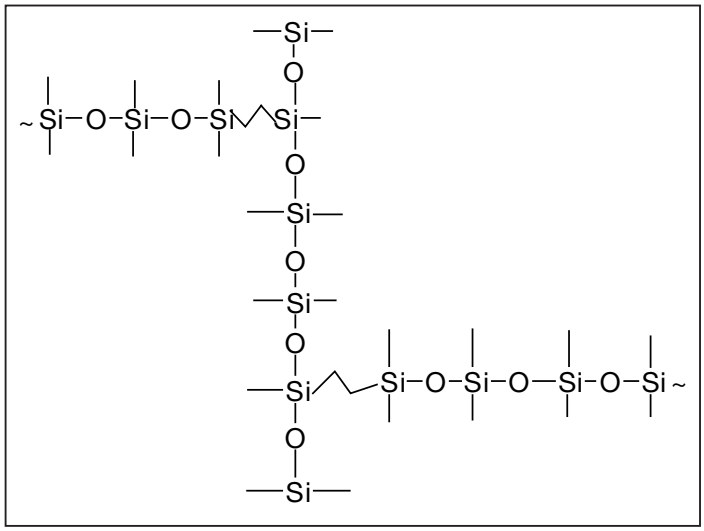
Reactive system

In addition to the conventional components of an addition-cured silicone, the Express™ 2 Wash Materials also contain reactive carbosilane crosslinking agents that modify the network (produced on setting):



The incorporation of carbosilanes in the polymer network results in a chemical matrix with a strongly increased crosslinking density (Fig. 9). This increase in the crosslinking density improves the mechanical characteristics of the elastomer produced and can be seen in the greatly increased tensile strength and toughness (for detail see below) of the cured impression.

Conventional network



Reinforced network

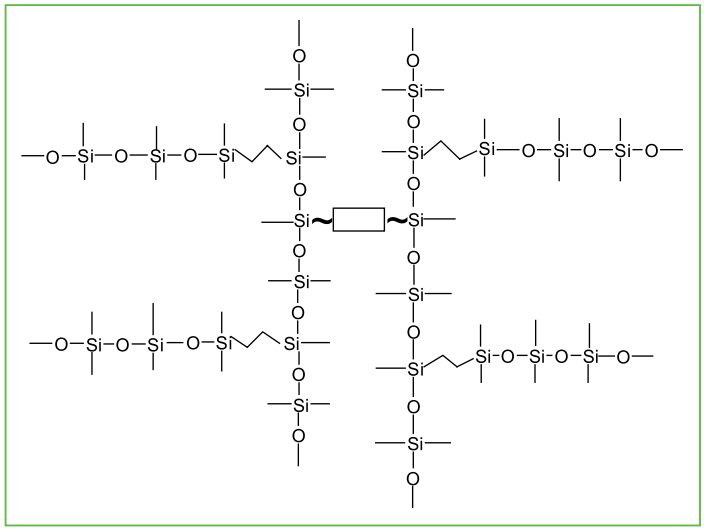


Fig. 9: Comparison in network density of a conventional and reinforced VPS network

Clinically Relevant Properties of Express™ 2 Wash Materials

The overall goal of an impression is to create an exact copy of the dentition, especially the detailed reproduction of the preparation margins – a prerequisite for an excellent fitting restoration. To capture the margin an impression material needs to have excellent properties in the unset stage, especially a high hydrophilicity and a very good flowability. To avoid any kind of permanent deformation when the impression is removed from the mouth, an impression material needs superior properties in the set stage. The new Express™ 2 VPS Impression Materials meet these requirements. Its excellent material properties are a key factor for clinical success, even under challenging clinical conditions.

1. Precisely capture the margin through strong hydrophilicity and very good flowability:

A) Hydrophilicity

The hydrophilicity of an impression material can contribute to the reproduction of details in a moist environment. The method most often used to determine the hydrophilicity of an impression material is the contact angle measurement. In this test a water droplet is placed onto the surface of a specimen and then the spreading of the drop across the surface is observed and the contact angle is measured. The lower the contact angle, the higher the hydrophilicity.

Fig. 10 shows below the contact angles on set impression material as a function of time for Express™ 2 Light Body *Standard* and several other leading VPS Impression Materials of same setting version and comparable viscosity. Over the entire observation period of 30 seconds, Express 2 VPS Impression Materials show a much lower contact angle than most of the other leading VPS materials tested. Especially in the first 2 seconds Express 2 shows a much stronger decrease in contact angle than any other of the tested VPS materials. After 2 seconds, the contact angles for the Express 2 washes are already below 10°, whereas that of the best competitor is still higher than 30°.

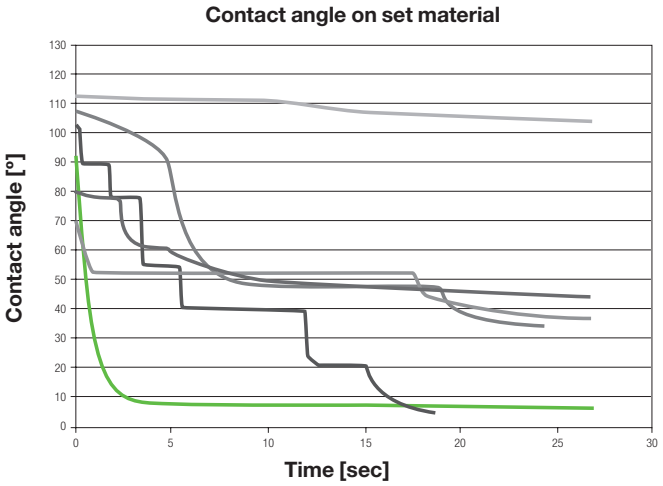


Fig. 10: Contact angle comparison of different VPS Impression Materials (set stage). Express™ 2 Light Body *Standard* shows the fastest decrease in contact angle and therefore outstanding hydrophilicity among all leading VPS Impression Materials tested.
Source: 3M ESPE internal data.

From a clinical perspective it is important that a VPS material displays its hydrophilicity the very first seconds when it is in contact with tooth surfaces and soft tissue. In this respect, based on set material, Express™ 2 wash materials are superior to the other the measured VPS materials – the much faster decrease in contact angle for Express 2 Light Body *Standard* in the first 2 seconds reflects a better wettability of the preparation surfaces, and also a better performance in a moist environment. As a consequence, impressions made with Express 2 VPS Impression Materials show very good detail reproduction, even under challenging clinical conditions. The strong hydrophilicity of the Express 2 wash products also is an advantage for the dental laboratory, when the impression is poured.

B) Flow Properties:
Upon syringing impression wash materials require special rheological properties in order to ensure optimal coverage of the preparation surface areas. Express™ 2 Wash Materials fulfill this criterion in an excellent manner.

Express™ 2 Wash Materials come in different viscosities: :

- Light Body *Flow*
- Light Body *Standard*
- Ultra-Light Body

Express™ 2 Light Body *Flow* (-Quick) offers a great flow to the tooth surface and gingiva while still retaining sufficient drip resistance. Upon syringing, the material flows into the sulcus almost by itself. Express™ 2 Light Body *Standard* (-Quick) is slightly more viscous. It stays nicely on the tooth while still offering good flow characteristics.

Express™ 2 Ultra-Light Body Quick has been developed especially for the 2-step technique, in combination with Express™ 2 Penta™ Putty. It offers a very low viscosity as well as a very high structural viscosity (thixotropy). This special property profile allows it to flow very well and to create very thin layers in the second impressions.

Fig. 11: Flow to tooth and gingiva of Express™ 2 Light Body *Flow* (green) and Express™ Light Body *Standard* (lavender) wash materials. The more flowable Express™ 2 Light Body *Flow* creates a smooth surface, whereas Express™ 2 Light Body *Standard* exhibits more structure.

2. Reproduce the margin accurately through distortion-free mouth removal:

When an impression is removed from the mouth, it is exposed to two principal forces, elongation and compression. Insufficient recovery from these two forces is a common cause for deformed/distorted preparation margins and, as a consequence, for poorly fitting restorations. Express 2 product has a unique ability to withstand these forces, making it an excellent choice compared to other VPS Impression Materials.

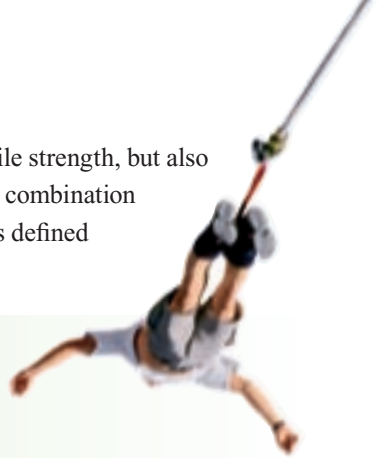
Key impression material characteristics related to mouth removal:

- ability to elongate and compress
- ability to avoid tearing
- ability to recover from elongation

- **high elongation and compression potential**
- **high tensile strength**
- **nearly 100 % recovery from deformation and compression**

A) Toughness:

In order to avoid tearing an impression material not only has to have a high tensile strength, but also a high elongation potential that allows the material to stretch upon removal. The combination of these two parameters is described as toughness (Fig. 12). Toughness [Joule] is defined as the total amount of energy an impression material can absorb until it tears.



Toughness can be easily explained by comparison with a bungee jumper who has to rely on his rope. The rope needs to elongate but must not tear.

In Fig. 12 two hypothetical impression materials with the same toughness – identical areas in the diagram – are shown. Impression material 1 is characterized by a very high elongation potential, but a relatively low tensile strength. Impression material 2 has a very tensile strength, but its elongation potential is quite low. The toughness of an impression material therefore much better reflects its ability to withstand the forces it is exposed to during mouth removal than just its tensile strength. A high toughness is also an advantage for the dental laboratory when fabricating the die model.

Toughness comparison of two different impression materials

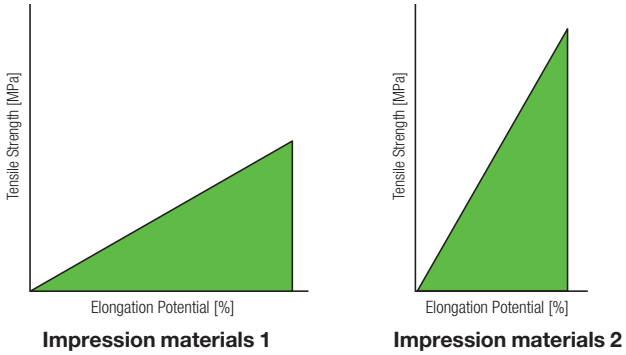


Fig. 12: Diagram showing the relation between Tensile Strength and Elongation Potential defined as Toughness. Both hypothetical impression materials have the same toughness (with identical areas in diagram). In order to be tough, an elastomeric rubber requires both, a high tensile strength as well as high elongation potential.

In comparison with different VPS wash materials, Express™ 2 Light Body *Standard* displays very high values for toughness (Fig. 13). The values are noticeably higher than those for Aquasil™ Ultra LV, President™ Plus Jet light and Affinis™ Regular Body. Please note that the toughness values for Express™ 2 Light Body *Standard* exceed those for Aquasil Ultra LV, despite the higher tensile strength of the latter product. A high tensile strength alone therefore does not guarantee that an impression material will not tear when being stretched. At the same time it has to have a high elongation potential, which is higher for Express 2 Light Body *Standard* than for Aquasil Ultra LV. Clinically this means that Express 2 impressions are less likely to tear upon mouth removal compared with other leading VPS impression materials.

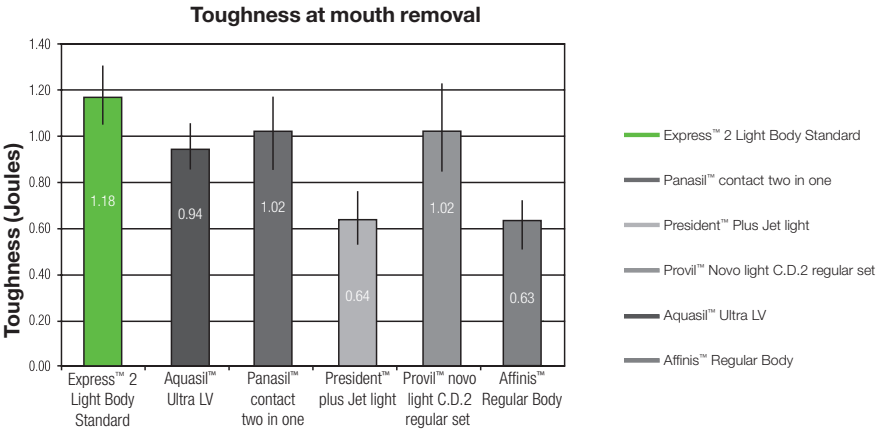


Fig. 13: Toughness values at mouth removal for different VPS Wash Materials of same setting version (regular) and comparable viscosity. Express™ 2 Light Body *Standard* exhibits noticeable higher toughness values than Aquasil™ Ultra LV, President™ Plus Jet light and Affinis™ Regular Body.

Source: 3M ESPE internal data

B) Recovery from compression and elongation:
We have seen above that Express™ 2 VPS Impression Material has a very high potential to resist tearing. This alone is not enough to reproduce the "correct" distortion-free margin. To achieve this, an impression material must show excellent recovery from the compressive and elongation forces it experiences upon mouth removal.

Precision impression materials must all fulfil the minimum requirement for recovery from compression of 96,5 % (the recovery from compression is an ISO test measurement). Typically the materials show values of >99 % in this test, meaning a permanent deformation of 1 % or even less after compression. But do these materials behave the same way if they are elongated instead of compressed?

High recovery from elongation is important for the area around the preparation margin, especially in clinical situations with a deep sulcus, undercuts and interproximal spaces. In these places the impression material is exposed to strong elongation forces during removal from the mouth.

The results of a 3M ESPE internal comparative study on the recovery from elongation demonstrate a superb performance of Express 2 wash material for this parameter.
In this test, paddle shaped test specimens of different VPS materials are cured in a water bath at 35° C, according to the manufacturer's recommended setting times. After curing, the paddles are stretched by 150 % in a universal material testing machine (Zwick Z020). Then the material is allowed to recover for 2 h before the recovery from elongation is measured.

Fig. 14 shows that Express™ 2 Light Body *Standard* recovers nearly 100 % after stretching. Its permanent deformation is only 0,25 %. In contrast Aquasil™ Ultra LV exhibits a large permanent deformation of 2,2 % (Lot: 041030). Clinically this means that even when exposed to strong elongation forces, Express 2 Light Body *Standard* can maintain its original dimensions, whereas impression materials with considerably lower recovery after elongation may experience a permanent deformation – potentially leading to distortions and therefore to poor fit of restorations.

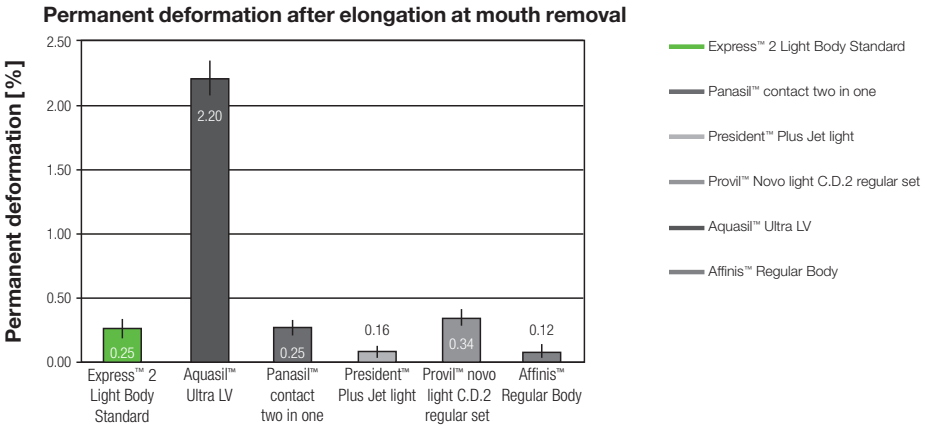


Fig. 14: Permanent deformation after elongation for different leading VPS impression materials. Express™ 2 Light Body *Standard* (and some other VPS materials) recover much better than Aquasil™ Ultra LV making them less likely to distort upon mouth removal.
Source: 3M ESPE internal data – all values adjusted for polymerization shrinkage.

The nearly 100 % recovery from elongation for the Express 2 products is also an important advantage for the dental technician. While the impression is removed from the cast, it is again exposed to elongation and compressive forces. To benefit from mulitiple pouring of VPS impressions, superb recovery from deformation is essential.

3. Get Outstanding Balance of Clinically Relevant Properties:

Impression materials often stand out with some properties, like tensile strength or hydrophilicity. For clinical success, however, it is essential that an impression material shows it excellence on all parameters that are of clinical importance.

Important properties determining the clinical success of a precision impression are:

- Hydrophilicity
- Tensile strength
- Elongation potential
- Toughness
- Recovery from elongation

They all have been discussed in detail in the previous sections. In order to determine the overall clinical performance of an impression material the five properties are now compiled in a so called star chart.

In order to properly compare the five properties, they all are showed on a common scale ranging from 0 to 10, in which 0 = poor, and 10 = excellent. The higher the value a product receives for a certain parameter (e.g. hydrophilicity), the better it performs. This means, the larger the area of the pentagon, the better the overall performance of the product.

Express™ 2 Light Body *Standard* shows a very convincing performance in this compilation of clinically important properties (Fig. 15). It displays the largest pentagon of all tested leading VPS Impression Materials. Moreover, it is the only material that performs very well in each of the five tested properties, whereas all the other tested VPS products show weaknesses at least for one property.

The outstanding balance of properties of Express 2 offers an excellent potential for highly accurate impressions and better fitting restorations – a benefit for dentist, patient and dental technician.

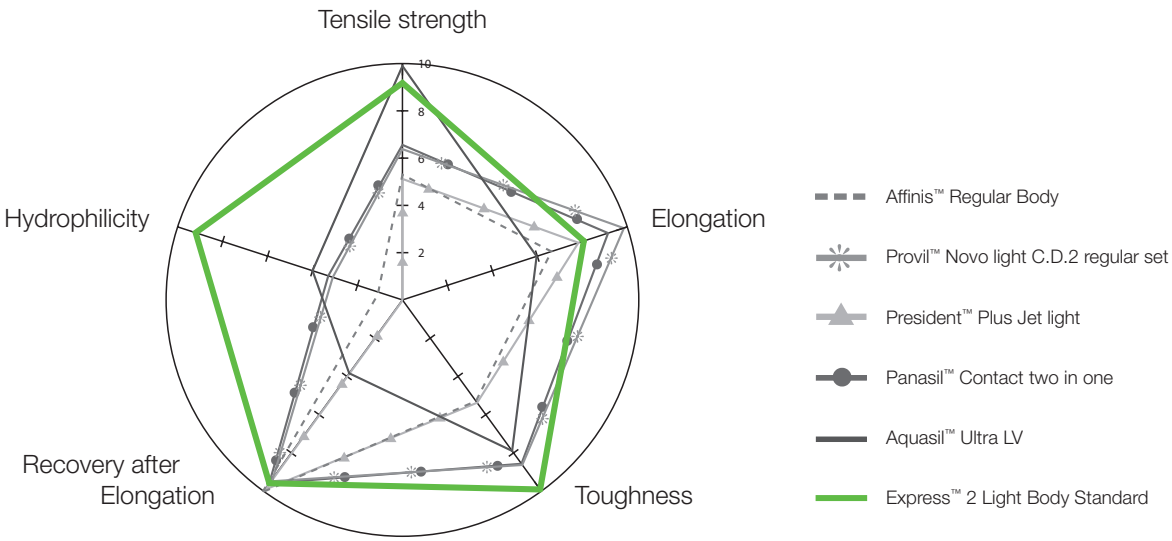


Fig. 15: Compilation of 5 clinically important impression material parameters: Tensile strength, %Elongation, Toughness, Recovery from elongation, Hydrophilicity*. Shown are Express™ 2 Light Body *Standard* and other leading VPS impression materials of same setting version and comparable viscosity. Values for each parameter are given in a scale from 1 to 10 in which 1 = poor and 10 = excellent. Overall Express™ 2 Light Body *Standard* shows the best overall performance – covering the biggest area in the diagram and with no value below 8.

*** Waterdrop contact angle on set material after 2 seconds.**
Source: 3M ESPE internal data

Express™ 2 Penta™ H/ Express™ 2 Penta™ H Quick – Tray Materials

A high hydrophilicity is not only advantageous for the wash material, but also for the tray material, especially when the 1-step impression technique is applied. All aspects of the prepared teeth, including the soft tissue, which are not covered by the wash material, will be captured by the tray material. This also holds for the adjacent teeth where no wash was applied. The more hydrophilic the tray material, the better it flows to the moist and wet surfaces of both teeth and soft tissue upon tray seating.

Express™ 2 Penta™ H as well as Express™ 2 Penta™ H Quick VPS Impression Materials exhibit a very high hydrophilicity as can be seen in Fig. 16. In this chart the contact angles of set impression materials are shown after 2 and 10 seconds. The lower the contact angle, the higher the hydrophilicity of an impression material. For both points of time Express 2 Penta H (and H Quick) display the lowest contact angles – highest hydrophilicity – out of all leading VPS materials tested. Especially the very low 2 second values (37°) demonstrate how fast the Express 2 materials exhibit their hydrophilic properties.

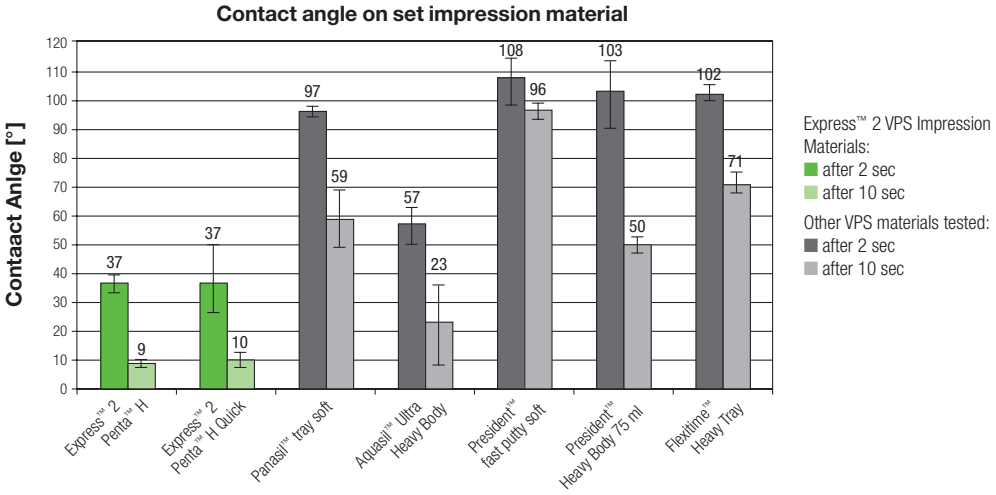


Fig. 16: Contact angle comparison of different VPS Impression Materials (set stage). Express™ 2 Penta™ H (and H Quick) exhibit the lowest contact angle both after 2 and 10 seconds and therefore excellent hydrophilicity among all leading VPS Impression Materials tested.

Source 3M ESPE internal data.

Clinically, this reflects a very good wettability of both teeth and soft tissue, resulting in a first-class performance of Express 2 Penta H (and H Quick) in the moist intra-oral environment. When combined with the new Express 2 wash materials from 3M ESPE, the Express 2 line stands for reliability in the impressioning process, even under challenging clinical conditions.

Clinical Cases

Replacement of Insufficient PFM Crown by All Ceramic Lava™ Crown

Clinical Case by Dr. med. dent. Gunnar Reich, Munich, Germany:

Initial situation:
Insufficient 2 year old PFM crown with large destruction of tooth 36 on its lingual aspect. Tooth 36 underwent endodontical treatment 1 ½ years ago. The old crown to be replaced by an all ceramic Lava™ Crown.

Treatment plan:
The old crown (Fig. 1) was removed, and the caries was completely excavated. Revision of the endodontical treatment was considered as not necessary based on X-ray examination and visual control. Two Rely™ X Fiber Posts were inserted in Tooth 36 (Fig. 2) to stabilize the following core build-up with Filtek™ Z250 (Fig. 3). Precision impression using 2-step impression technique with full arch metal trays was taken with Express™ 2 Penta™ H Universal Quick and Express™ 2 Light Body *Flow* Quick (blue, Figs. 4–7).

A second 2-step impression was taken with the somewhat thicker Express™ 2 Light Body *Standard* Quick Wash Material (pink, Fig. 8–10). Crown temporary was made with Protemp™ 3 Garant™ Composite for Temporary Crowns and Bridges, and cemented with RelyX™ Temp NE Temporary Cement. Final Lava™ restoration (Fig. 11) was permanently cemented with RelyX™ Unicem Self-Adhesive Universal Resin Cement (Fig. 12).

Case 1

Fig. 1: Initial situation-Insufficient PFM crown with large carious lesion at lingual aspect of tooth 36.

Fig. 2: Tooth 36 reinforced with 2 fiber posts, occlusal view.

Fig. 3: Tooth 36 after core build-up and circular chamfer preparation for Lava™ Crown restoration, occlusal view.

Fig. 4: Initial impression Express™ 2 Penta™ H Universal Quick after carving.

Fig. 5: Intra-oral syringing with Express™ 2 Light Body *Flow* Quick.

Fig. 6: Express™ 2 Penta™ H Universal Quick – Express™ 2 Light Body *Flow* Quick 2-step impression.

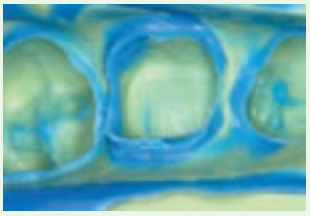


Fig. 7: Close-up 2-step impression Express™ 2 Penta™ H Universal Quick – Express™ 2 Light Body *Flow* Quick.

Fig. 8: Intra-oral syringing Express™ 2 Light Body *Standard* Quick 2-step impression.

Fig. 9: Express™ 2 Penta™ H Universal Quick – Express™ 2 Light Body *Standard* Quick 2-step impression.

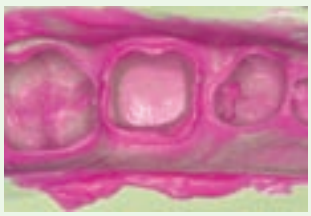


Fig. 10: Close-up 2-step impression Express™ 2 Penta™ H Universal Quick – Express™ 2 Light Body *Standard* Quick.

Fig. 11: Final Lava™ Crown on die model, occlusal view.

Fig. 12: Final Lava™ Crown in patients mouth, occlusal view.

Esthetics in the Anterior Region: Two 3-Unit PFM Bridge Restorations in the Upper Anterior Region

Clinical Case by Dr. med. dent. Christoph Zawta, Meran, Italy

Initial Situation:

Poor esthetics in the upper anterior region due to old insufficient PFM bridges 13 – 11 and 21 – 23 with recurrent caries and partly exposed crown margins (Figs. 1, 2). The patient was very unsatisfied with this situation. In order to re-establish the esthetic aspect in the anterior region the old restorations were replaced by new PFM bridges and tooth 24 was restored with an Empress-Inlay.

Treatment plan:

After removal of the insufficient restorations and restorative pre-treatment a direct bridge temporary (3M™ ESPE™ Protemp™ 3 Garant™) was inserted. (Fig. 3). Subsequently periodontal pre-treatment was performed. After a healing period of 3 months a chamfer preparation was carried out for the abutment teeth 13, 11, 21, 23.). Ultrapak cords (Size 00, 0) have been placed for retraction of the gingival tissue in two-cord technique. (Fig. 4)

The precision impression using 1-step impression technique was done with Express™ 2 Penta™ H und Express™ 2 Light Body *Standard* (Fig. 5). Tray and wash material offer a very good color contrast allowing an excellent readability of all relevant details. Fig. 6 exhibits a detailed view of the upper central incisors showing that the preparation margins for both abutment teeth are entirely captured. Neither tears nor voids occurred at the preparation margins or at other relevant areas. A master model has been created (Fig. 7). Fig. 8 shows the precise fit of the high-gold alloy frameworks on the master model. The intra-oral try-in of the frameworks showed an excellent precision of fit (Fig. 9). After try-in of the firstly fired frameworks the PFM bridges with ceramic shoulders were glaze fired and finalized. (Fig. 10). The bridge restorations were permanently cemented with RelyX™ Unicem (Figs. 11, 12).

Case 2

Fig. 1: Initial situation – Insufficient PFM bridges.

Fig. 2: Close-up initial situation – insufficient PFM bridges.

Fig. 3: Close-up Protemp™ 3 Garant™ temporary in mouth.

Fig. 4: Prepared teeth 13, 11, 21, 23 with retraction cords in place.

Fig. 5: Precision impression Express™ 2 Penta™ H – Express™ 2 Light Body *Flow.*

Fig. 6: Close-up precision impression Express™ 2 Penta™ H – Express™ 2 Light Body *Flow* teeth 11, 21.

Fig. 7: Master model sawed, prepared teeth, buccal view.

Fig. 8: Bridge frameworks on master model, buccal view.

Fig. 9: Bridge frameworks in patients mouth, buccal view.

Fig. 10: Final bridge restoration on master model, buccal view.

Fig. 11: Final restoration inserted in mouth, buccal view.

Fig. 12: Smiling patient with final restoration.

All Ceramic Lava™ Crown Restoration

Clinical Case by Dr. med. dent. Vivien Porsfeld, Munich, Germany

Initial situation:
Endodontically treated tooth 26 temporarily restored with Filtek™ Flow (Fig. 1). Tooth 26 required full crown restoration due to large occlusal defect and advanced crack at its mesial aspect. The patient wanted to have an all ceramic restoration.

Treatment plan:
After removal of temporary restoration, tooth 26 has been build-up with Filtek™ Z250 followed by a circular chamfer preparation for the Lava crown (Fig. 2). Precision impression using 1-step impression technique with full arch metal tray was taken with Express™ 2 Penta™ H Quick and Express™ 2 Light Body *Flow* Quick (blue, Figs. 3, 4, 5). A second precision impression was taken with the somewhat thicker Express™ Light Body *Standard* Quick wash material (pink, Fig. 6).
Both new wash material consistencies showed great flow characteristics – they perfectly flowed into the deep sulcus, far below the preparation margins. For both impressions the color contrast between tray and wash material was very good, allowing an excellent readability of all relevant details. Both impressions entirely captured the preparation margins of the prepared teeth (Figs. 5, 6). Neither tears nor voids occurred at the preparation margins or at other relevant areas.
Impression for the temporary was made with 3M™ ESPE™ Directed Flow Impression Tray and Position™ Penta™. Crown temporary was made with Protemp™ 3 Garant™, and cemented with RelyX™ Temp NE. Final Lava™ restoration (Figs. 7, 8) was permanently cemented with RelyX™ Unicem.

Case 3

Fig. 1: Initial situation tooth 26 temporarily restored with Filtek™ Flow.

Fig. 2: Tooth 26 prepared, with retraction cords in place, occlusal view.

Fig. 3: Intra-oral syringing with Express™ 2 Light Body *Flow* Quick.

Fig. 4: Express™ 2 Penta H Quick – Express™ 2 Light Body *Flow* Quick impression.

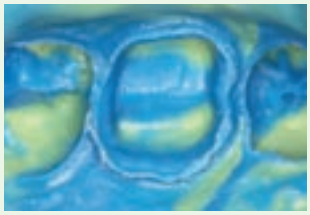


Fig. 5: Close-up Express™ 2 Penta™ H Quick – Express™ 2 Light Body *Flow* Quick impression.

Fig. 6: Close-up Express™ 2 Penta™ H Quick – Express™ 2 Light Body *Standard* Quick impression.

Fig. 7: Final Lava™ Crown restoration on die model, buccal view.

Fig. 8: Final Lava™ restoration inserted in mouth, occlusal view.

Replacement of Insufficient 8 Year Old PFM Bridge by All Ceramic 3M™ ESPE™ Lava™ Restoration

Clinical Case by Dr. med. dent. Vivien Porsfeld, Munich, Germany

Initial situation:

Extended carious lesion under PFM bridge 45–47 mesiobuccally at tooth 45 due to poor fit (large marginal gap of >500µm). Tooth 45 experienced endodontical treatment 8 years ago.

Treatment plan:

The old bridge (Fig. 1) was removed, and the caries completely excavated. X-ray and visual control displayed that revision of the endodontical treatment was not necessary as the root canal filling in situ was still in good condition and no apical inflammation process could be diagnosed. Tooth 45 was reinforced with a RelyX™ Fiber Post followed by a core build-up with Filtek™ Z250 Universal Composite. Then both bridge abutment teeth were prepared for the subsequent 3M ESPE Lava Restoration (Fig. 2). Precision impression using 2-step technique was taken with Express™ 2 Penta™ Putty and Express™ 2 Ultra-Light Body Quick material – a perfect combination for this impression technique (Figs. 3–5). Express 2 Ultra-Light Body Quick material created very thin layers in the impression, demonstrating its high structural viscosity (thixotropic behavior). The Ultra-Light Body wash showed an excellent flow into the sulcus and accurately reproduced the preparation margins for both abutment teeth. A second precision impression using 1-step (simultaneous) technique was taken with Express 2 Penta™ Putty and the somewhat thicker Express™ 2 Light Body *Standard* wash material (Figs 6, 7). The Express™ 2 Light Body *Standard* wash material also flowed very nicely into the sulcus and entirely reproduced the preparation margins for both prepared teeth. This clearly illustrates that Express 2 Penta Putty is also an excellent impression material for the 1-step impression technique, when combined with Express 2 Light Body *Standard*. The impression for the bridge temporary was made with 3M ESPE Position™ Tray and Position™ Penta™ (Fig. 8). The bridge temporary was made with Protemp™ 3 Garant™, cemented with RelyX™ Temp. NE. The final restoration, cemented with RelyX™ Unicem showed an excellent marginal, approximal and occlusal fit. It required only very minor occlusal adjustments (Figs. 10–12).

Case 4

Fig. 1: Initial situation buccal view.

Fig. 2: Retraction cords packed occlusal view.

Fig. 3: Express™ 2 Penta™ Putty – Express™ 2 Ultra-Light Body Quick 2-step impression close up 45–47.

Fig. 4: Express™ 2 Penta™ Putty – Express™ 2 Ultra-Light Body Quick 2-step impression close-up 45.

Fig. 5: Express™ 2 Penta™ Putty – Express™ 2 Ultra-Light Body Quick 2-step impression close-up 47.

Fig. 6: Express™ 2 Penta™ Putty – Express™ 2 Light Body *Standard* 1-step impression close-up 45–47.

Fig. 7: Express™ 2 Penta™ Putty – Express™ 2 Light Body *Standard* 1-step impression close-up 47.

Fig. 8: Position™ Penta™ Quick impression with Protemp™ 3 Garant™ temporary close-up.

Fig. 9: Close-up lava framework on die model buccal view.

Fig. 10: Close-up final Lava™ restoration on die model buccal view.

Fig. 11: Close-up final Lava™ restoration on die model occlusal view.

Fig. 12: Final Lava™ restoration inserted in mouth buccal view.

Paradigm™ C Glass Ceramic Inlay Restoration

Clinical Case by Dr. Med. Dent. Andreas Syrek, Munich, Germany

Initial situation:
12 year old insufficient amalgam fillings at teeth 45, 46 and 47 (Fig. 1). Teeth were restored with new 3M ESPE Glass Ceramic for the Cerec System (Paradigm™ C).

Treatment plan:
The old amalgam fillings were removed. No recurrent caries had developed at teeth 45–47, despite the insufficiency of the fillings, especially at tooth 47. Teeth were prepared for glass ceramic Paradigm™ C inlay restorations (Figs. 2, 3). Precision impression using 1-step impression technique with full arch metal tray was taken with Express™ 2 Penta™ H and Express™ 2 Light Body *Flow* (green). The new Express™ 2 wash material shows excellent flow characteristics (Fig. 4). It incredibly captured all relevant details of the preparations and their margins (Fig. 5, 6). A second precision impression with the somewhat thicker Express™ 2 Light Body *Standard* wash material (Fig. 7, lavender) showed the same high reproduction of detail (Fig. 8).

Inlay temporaries were made with Protemp™ 3 Garant™ material, and cemented with RelyX™ Temp NE cement. Paradigm™ C Glass Ceramic Inlays (Fig. 9) were pretreated with HF and RelyX™ Ceramic Primer and permanently Cemented with RelyX™ Unicem cement (Fig. 10).
Final restorations (Fig. 12) were finished with 3M™ ESPE™ Sof-Lex™ discs (Fig. 11) and polishing cups.

Case 5

Fig. 1: Initial situation, old insufficient amalgam fillings teeth 45, 46, 47 occlusal view.

Fig. 2: Prepared teeth occlusal view.

Fig. 3: Retraction cords in place.

Fig. 4: Intra-oral syringing Express™ 2 Light Body *Flow*.

Fig. 5: Express™ 2 Penta™ H – Express™ 2 Light Body *Flow* impression.

Fig. 6: Express™ 2 Penta™ H – Express™ 2 Light Body *Flow* impression close-up.

Fig. 7: Intra-oral syringing Express™ 2 Light Body *Standard*.

Fig. 8: Express™ 2 Penta™ H – Express™ 2 Light Body *Standard* impression close-up.

Fig. 9: Paradigm™ C inlays on die model-occlusal view.

Fig. 10: Paradigm™ C inlays permanently cemented with RelyX™ Unicem.

Fig. 11: Paradigm™ C polished with Sof-Lex™ disc.

Fig. 12: Final Paradigm™ C restorations.

3M ESPE Internal Application Test

The Express™ 2 VPS Impression Materials underwent extensive clinical testing within a 6 week application test involving 87 dentists from Germany, France and Italy.

The participating dentists covered a broad range of 3M ESPE and competitive VPS precision impression material users. They all were already equipped with a Pentamix™ Automatic Mixing Unit in their dental offices.

A total of 1125 precision impressions were taken within the application test. 57 % were taken with the 1-step impression technique, and the remaining 43 % with the 2-step impression technique.

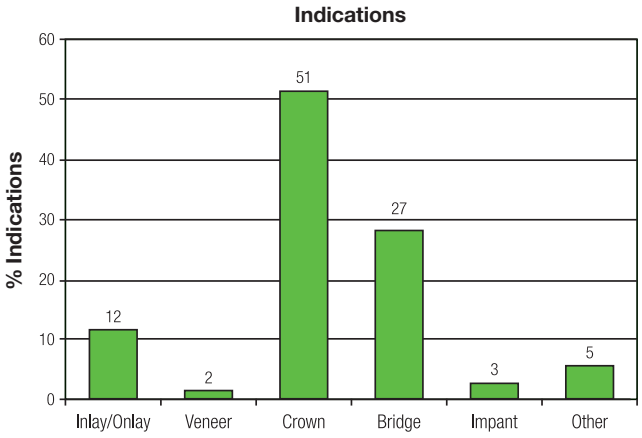


Fig. 17: Indications for which Express™ 2 VPS Impression Materials were used

The new materials were mainly used for full crown (51 %) and bridge (27 %) restorations.

Satisfaction with the Express™ 2 VPS Impression Materials (Fig. 18) was high.

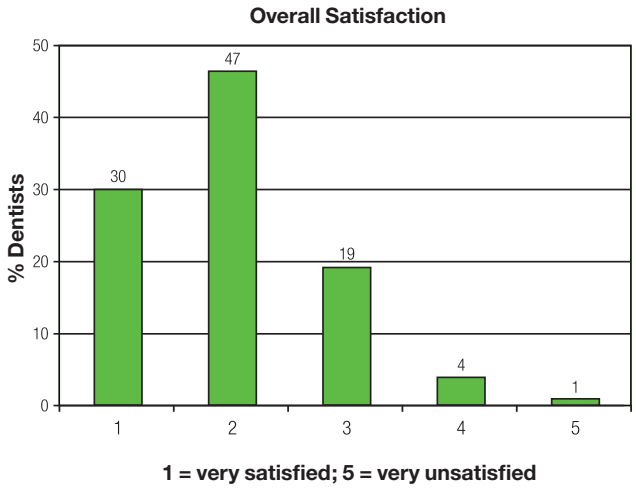


Fig. 18: Overall satisfaction with Express™ 2 VPS Impression Materials

Evaluators judged the new products to be very good across a wide variety of material characteristics and slightly better than their currently preferred products (Figs. 19, 20), with all values being <3.

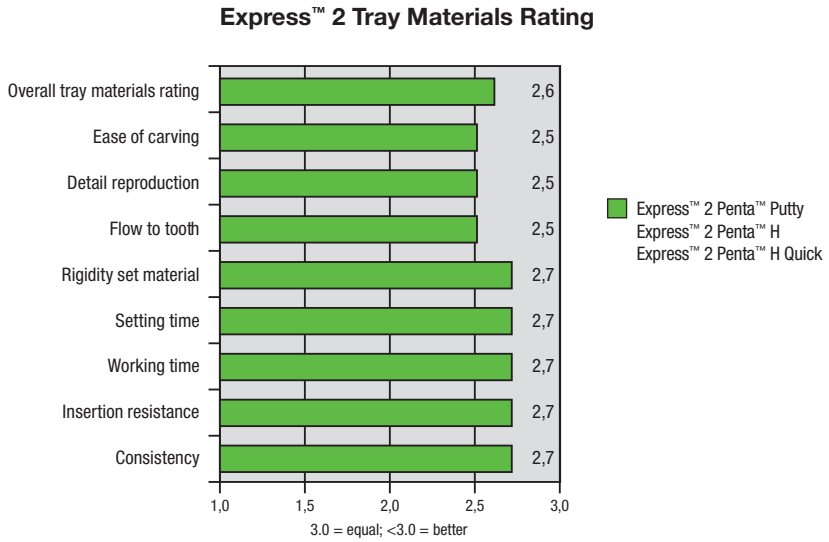


Fig. 19: Rating of Express™ 2 tray materials compared with currently preferred tray material in a scale from 1 to 5 (1= much better, 3= equal, 5 = much worse). Express™ 2 products are rated better for all material characteristics (values < 3.0).

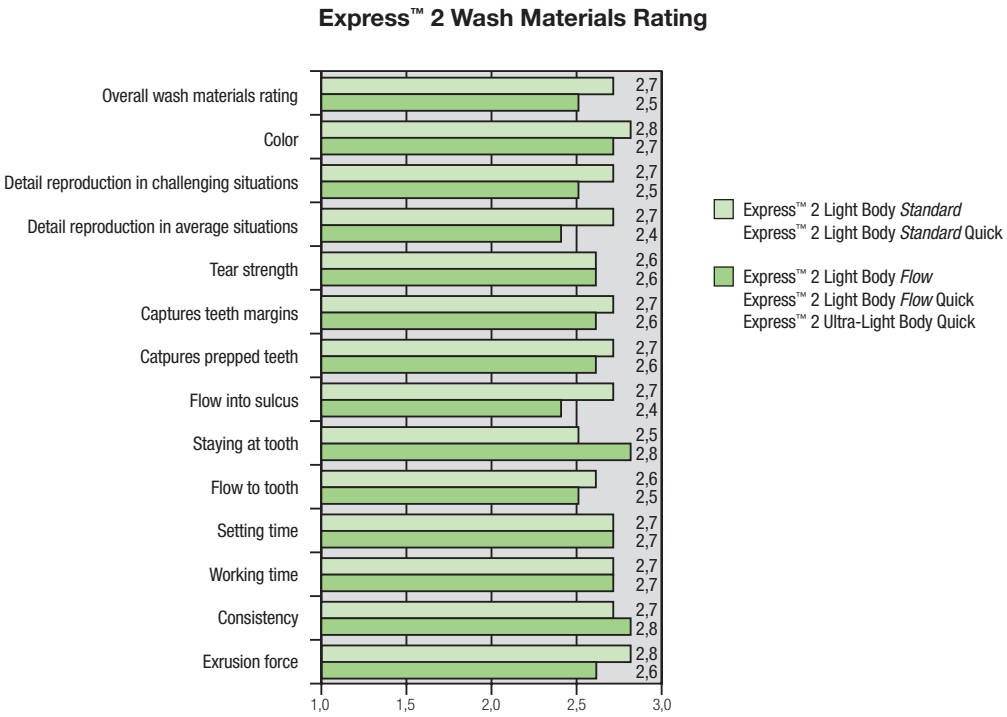


Fig. 20: Rating of Express™ 2 Wash Materials compared with currently preferred wash material in a scale from 1 to 5 (1= much better, 3= equal, 5 = much worse). Express™ 2 products are judged better for all material characteristics (values < 3.0).

82 % of the participants would recommend the new Express™ 2 VPS Impression Materials to their colleagues.

These results underline the very good clinical performance of the Express 2 Impression Materials. Express 2 products deliver precise impression results not only under average clinical conditions, but also under challenging conditions, where it really counts.

Information for Use

Product Description

These instructions for use apply to the subsequently listed vinyl polysiloxane impression materials, which are used for the one-step and two-step impression technique. All products are manufactured by 3M ESPE.

Quick Setting Products:

Product Name	ISO 4823	ISO 4823 Consistency	Paste Color	Mixing Ratio (Vol.)	Mixing Device
Express™ 2 Penta™ H Quick	Type 1	heavy-bodied	green	5:1	Pentamix™ Pentamix™ 2
Express™ 2 Penta™ H Universal Quick	Type 1	heavy-bodied	green	5:1	Pentamix™ Pentamix™ 2
Express™ 2 Light Body *Flow* Quick	Type 3	light-bodied	blue	1:1	Garant™ Dispenser
Express™ 2 Light Body *Standard* Quick	Type 3	light-bodied	pink	1:1	Garant™ Dispenser
Express™ 2 Ultra-Light Body Quick	Type 3	light-bodied	orange	1:1	Garant™ Dispenser

Regular Setting Products:

Product Name	ISO 4823	ISO 4823 Consistency	Paste Color	Mixing Ratio (Vol.)	Mixing Device
Express™ 2 Penta™ Putty	Type 0	putty	green	5:1	Pentamix™ 2
Express™ 2 Penta™ H	Type 1	heavy-bodied	ocher	5:1	Pentamix™ Pentamix™ 2
Express™ 2 Light Body *Flow*	Type 3	light-bodied	green	1:1	Garant™ Dispenser
Express™ 2 Light Body *Standard*	Type 3	light-bodied	magenta	1:1	Garant™ Dispenser

Express 2 Penta Putty can only be mixed in the Pentamix™ 2 mixing device, manufactured by 3M ESPE. The material can not be mixed in an earlier Pentamix version due to the lower mixing speed of this device. Express 2 Penta H Quick and Express 2 Penta H can be mixed in all versions of Pentamix mixing devices. All other products are statically mixed and directly applied using the Garant™ Dispenser, manufactured by 3M ESPE.

- These Instructions for Use should be kept for the duration of product use. For all additionally mentioned products please refer to the corresponding Instructions for Use.

Areas of Application

All precision impressions (of e.g.: crown, bridge, inlay and onlay preparations)

Preparation

Block out undercuts or interdental spaces sufficiently to aid impression removal from the teeth after setting, as otherwise impression removal from the mouth may be difficult or could lead to the extraction of natural teeth or prostheses. Blocking is particulary necessary when using Express 2 Penta Putty or any other impression material with increased shore hardness.

Impression Tray:

All impression Trays generally used for precision impressions are suitable. Rigid impression trays are recommended for two-step impression technique.

- For sufficient adhesion, apply VPS Tray Adhesive, manufactured by 3M ESPE, on the tray and allow it to dry cempletely, whereby the ideal drying time is 5 – 15 minutes.

Penta™ Material:

- Place the Penta™ Foil Bags into the designated metal-reinforced Penta™ Cartridges.
- Insert the loaded cartridge into the Pentamix Mixing Unit.
- Attach a red Penta™ Mixing Tip, manufactured by 3M ESPE.
- Turn the plungers of the mixing unit downward with the hand-wheel until resistance is noticed, do not force.
- When using new foil bags, start mixing and extrude a small amount of paste, until it is uniform in color. Discard this first amount of paste.
  – Paste color: please see “Product Description”.
  – Material that has set inside the Penta Mixing Tip should not be extruded by force, as this may damage the Penta Cartridge and Penta Mixing Tip and result in the formation of leaks.
- Please follow the section “Impression Taking” for tray filling procecedure.

Garant™ Dispenser:

- Insert the cartridge with the light-bodied impression material into the Garant Dispenser.
- Prior to application, check that both Garant cartridges openings are not clogged.
- When using new Garant cartridges, extrude a small amount of paste without the mixing tip, until base paste and catalyst are evenly extruded.
- Attach a yellow Garant™ Mixing Tip, manufactured for 3M ESPE, to the cartridge.
- For intraoral application attach a yellow Garant™ Intraoral Tip onto the Garant Mixing Tip.
- If required: enlarge the exit opening for the intraoral tip by cutting it with a scalpel.
- Make sure that base paste and catalyst are mixed completely and are extruded in an uniform color.
  – Paste color: see “Product Description”
  – Material that has set inside the Garant Mixing Tip should not be extruded by force as this may damage the Garant™ Cartridge and Garant Mixing Tip and result in the formation of leaks.

Retraction

Suitable retraction agents include aluminium hydroxide chloride, aluminium sulfate or ferric sulfate solutions.

- Keep the areas, from which the impression is to be taken, dry during impression.
- The use of retraction cords may be required for subgingival preparations.
- Prior the impression, thoroughly remove residual retraction material by flushing and drying.

Times

Product	Working Time at 23° C / 74° F from start of mixing* min : sec	Intraoral Syringe Time min : sec	Intraoral Setting Time min : sec
Quick Setting			
Express™ 2 Penta™ H Quick	1:15	–	2:30
Express™ 2 Penta™ H Universal Quick	1:30	–	2:30
Express™ 2 Light Body *Flow* Quick	1:30	0:40	2:30
Express™ 2 Light Body *Standard* Quick	1:30	0:40	2:30
Express™ 2 Ultra-Light Body Quick	1:30	0:40	2:30
Intraoral setting time for all combinations of quick setting materials when using one-step technique:			2:30
Regular Setting			
Express™ 2 Penta™ Putty	1:30	–	3:00
Express™ 2 Penta™ H	2:00	–	3:30
Express™ 2 Light Body *Flow*	2:00	1:00	3:30
Express™ 2 Light Body *Standard*	2:00	1:00	3:30
Intraoral setting time for all combinations of regular setting materials using one-step technique:			
Express™ 2 Penta™ Putty	Express™ 2 Light Body *Flow* or Express™ 2 Light Body *Standard*		3:00**
Express™ 2 Penta™ H	Express™ 2 Light Body *Flow* or Express™ 2 Light Body *Standard*		3:30

* Start of mixing = Entry of paste into the mixing Tip.
** Due to the higher temperature of the Penta™ Putty paste extruded from the Pentamix™ 2, the intraoral setting of the syringe material is accelerated.

These are the processing times for products that have been stored at a temperature of 23° C / 74° F and 20 – 80 % relative humidity. These times are reduced due to higher temperatures of the product or prolonged if the temperature of the product is lower.

Impression Taking

One-step Impression Technique:

- At the start of mixing the Penta™ Impression Material, be sure to observe the entry of the paste into the Penta™ Mixing Tip, and ensure that the base paste and catalyst paste flow evenly into the mixing tip. The mixed paste must be extruded in a uniform color free of streaks.
  – Paste color: see “Product Description”.
- Load the impression tray prepared with adhesive, keeping the mixing tip permanently immersed in the paste to avoid the formation of air bubbles.
- While the tray is being loaded, apply the light-bodied paste around the cleaned and dried preparation from the bottom up. Keep the application nozzle permanently immersed in the paste to avoid the formation of air bubbles.
  – Depending on the number of units to be syringed, initiate application, so that the tray loading and application of material around the preparation are completed simultaneously.
  – Do not exceed processing times of tray material and syringe material to avoid incomplete and inaccurate impressions.
- Slowly insert the loaded tray into the mouth parallel to the long axes of the prepared teeth, and hold it in place without exerting pressure.
- Remove the impression from the mouth after completed setting.

Two-step Impression Technique:

- At the start of mixing the Penta™ Impression Material, be sure to observe the entry of the paste into the Penta™ Mixing Tip, and ensure that the base paste and catalyst paste flow evenly into the mixing tip. The mixed paste must be extruded in a uniform color free of streaks.
  – Paste color: see “Product Description”.
- Load the impression tray prepared with adhesive, keeping the mixing tip permanently immersed in the paste to avoid the formation of air bubbles.
- Slowly insert the loaded tray into the mouth parallel to the long axes of the prepared teeth, and hold it in place without exerting pressure.
- Remove the impression from the mouth after completed setting, clean and dry thoroughly.
- Excise undercuts and interdental septa etc. and cut spillways, if required.
- Insert the light-bodied impression material into the preliminary impression at the appropriate sites and/or apply around the cleaned and dried preparations, while keeping the application nozzle permanently immersed in the paste to avoid the formation of bubbles.
- Replace the preliminary impression into the mouth and hold it in place.
- Remove the impression from the mouth after completed setting.

After Impression Taking

Thoroughly examine and explore the sulcus of the prepared teeth and surrounding dentition. Remove any residual cured impression material from the mouth.

Hygiene

- Place the impression in a standard desinfectant solution, e.g.: Impresept™ * Immersion Disinfectant, manufactured for 3M ESPE. The duration complies with the instructions of the manufacturer. Do not leave the impression submerged in the disinfection solution for more than the specified amount of time as otherwise the impression may be damaged.
- After disinfection, clean the impression of any remaining disinfection solution by rising under running water for approx. 15 seconds.

* Impresept™ Immersion Disinfectant is not available in all countries.

Model Preparation

- The impression can be poured at the earliest two hours after removal from the mouth. There are no other time limitations for pouring.
- In order to attain a bubble-free model, rinse the impression with water shortly before pouring, remove excess water or use a silicone surfactant.
- Pour the impression with a standard dental die or model stone. The impression can be silver or copper plated.

Cleaning

- Garant™ Dispenser: remove paste that has not set using a cloth soaked in alcohol. The dispenser handle and plunger can be autoclaved up to a temperature of 135° C / 275° F. Disassemble the dispenser before autoclaving. Glutaraldehyde-based solutions can be used for disinfection.
- Impression Tray: the adhesive can be removed from re-usable impression trays using acetone.

Notes

- Completely remove the oxygen inhibition layer of composite materials, e.g. fillings or core buildups; it may impair or retard the setting of silicone impression materials.
- Keep the filled Penta™ or Garant™ Mixing Tip on top of the cartridge to serve as a closure until the next use. Removing and replacing the spent Penta or Garant Mixing Tip may lead to carry-over of paste and ensuing formation of clogs.
- Vinyl polisiloxane impression materials must not be combined with condensation type silicones or polyether impression materials. Even small traces can affect the setting process.
- Disposable latex gloves impair the setting of silicone impression materials. Vinyl gloves are more suitable.
- Under no circumstances may impressions come into contact with sovent-containing fluids. This could result in expansion an inaccurate stone models.

Precautionary Measures

3M ESPE MSDSs can be obtained from www.mmm.com or contact your local subsidiary.

Storage and Stability

Store the product at 15–25° C / 59–77° F. Do not use after the expiration date. Store set impressions at temperature below 30° C / 86° F.

Customer Information

No person is authorized to provide any information which deviates from the information provided in this instruction sheet.

Warranty

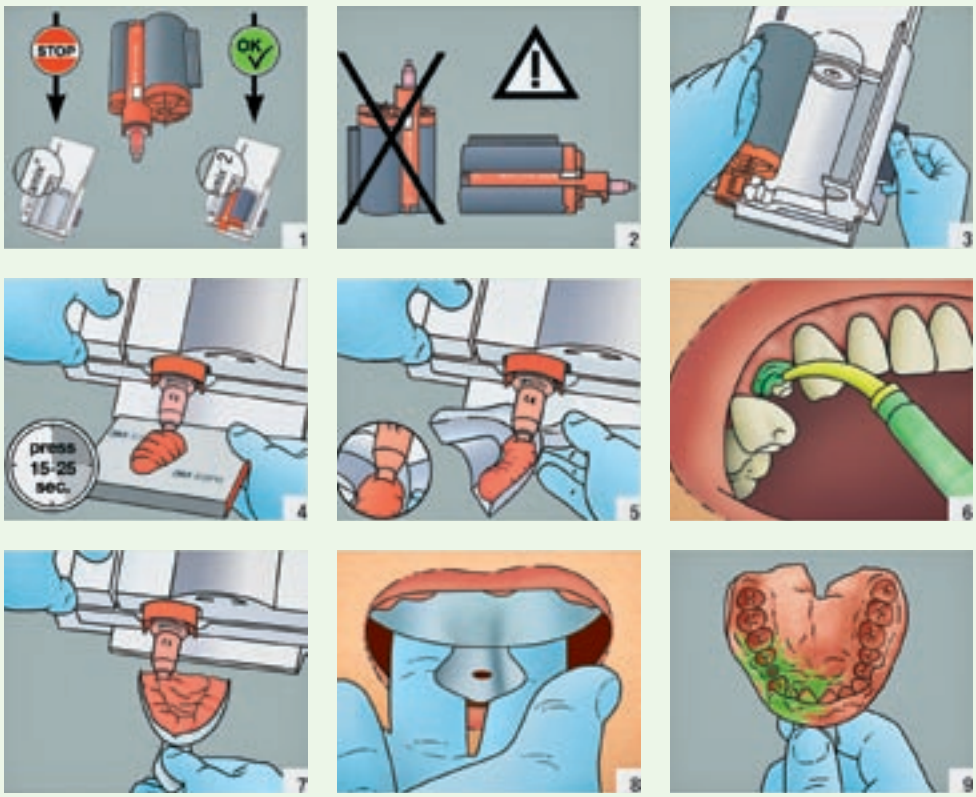
3M ESPE warrants this product will be free from defects in material and manufacture. 3M ESPE MAKES NO OTHER WARRANTIES INCLUDING ANY IMPLIED WARRANTY OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE. User is responsible for determining the suitability of the product for user's application. If this product is defective within the warranty period, your exclusive remedy and 3M ESPE's sole obligation shall be repair or replacement of the 3M ESPE product.

Limitation of Liability

Except where prohibited by law, 3M ESPE will not be liable for any loss or damage arising from this product, whether direct, indirect, special, incidental or consequential, regardless of the theory asserted, including warranty, contract, negligence or strict liablity.

Information as of April 2006

Step-by-Step Card



For One-Step Impression Technique:

Express™ 2 Penta™ H

Express™ 2 Penta™ Putty

Express™ 2 Penta™ H Quick

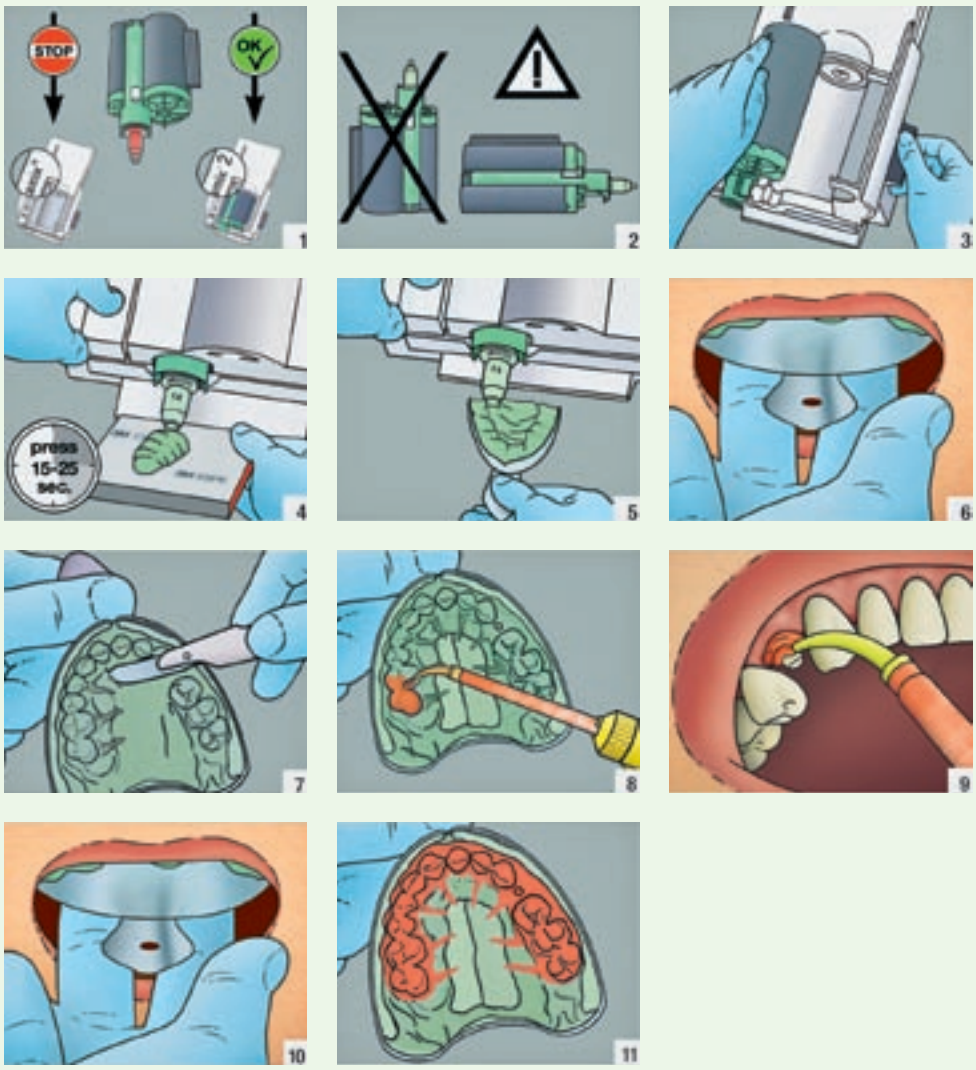
Express™ 2 Penta™ H Universal Quick

Express™ 2 Light Body Flow

Express™ 2 Light Body Flow Quick

Express™ 2 Light Body Standard

Express™ 2 Light Body Standard Quick



For Two-Step Impression Technique:

Express™ 2 Penta™ Putty

Express™ 2 Penta™ H Universal Quick

Express™ 2 Ultra-Light Body Quick

Express™ 2 Light Body Flow Quick

Frequently Asked Questions (FAQ's)

1. What Express™ 2 VPS Impression Materials viscosity combinations are recommended, and why?

2-step technique:
For the 2-step technique it is important that the tray material offers a high insertion pressure to push the wash material deep into the sulcus. Also the tray material must have good carving properties as well as a high hardness in the set stage. The latter is important for not being distorted during the second impression by the pressure that is applied to push the wash material into the sulcus. The wash material has to have the ability to generate very thin layers on the set tray material (in the initial impression.) Ideal are wash materials with a low viscosity and a high structural viscosity (thixotropic) allowing them to flow very well when pressure is applied. Highly viscous and only slightly thixotropic wash materials on the other hand would lead to thick layers on the set tray material or even displace it, causing distortions.

The ideal product combination for the 2-step technique is the combination Express™ 2 Penta™ Putty – Express™ 2 Ultra-Light Body Quick as it offers all of the described features.

For those who prefer a tray material with a lower insertion pressure we recommend Express™ 2 Penta™ H Universal Quick. It also offers a high hardness in the set stage and can be carved easily.

1-step technique:
For the 1-step technique the ideal tray material should be hydrophilic to perform well in the moist intra-oral environment. It has a somewhat lower hardness in the set stage for an easy mouth removal. Express™ 2 Penta™ H and Express™ 2 Penta™ H Quick have been designed to meet these requirements. It is difficult to recommend a certain viscosity of the wash material for this impression technique. It is more a matter of user preference and experience what viscosity to use. If a very good flowability is desired we recommend the Light Body *Flow* (-Quick) viscosity. In case it is more important that the wash material stays very well at the tooth, we recommend the Light Body *Standard* (-Quick) viscosity.

2-step and 1-step technique:
Quite a number of dentists wish to have an impression material that can be used for both, the 2-step and the 1-step technique.
For those dentists we recommend to use Express™ 2 Penta™ H Universal Quick – in case a heavy body consistency is desired. Alternatively Express™ 2 Penta™ Putty also can be used – in case a putty consistency is preferred.

No matter what tray material consistency – putty or heavy body – is preferred we recommend to use a low viscous wash material for the 2-step technique (Light Body *Flow* or Ultra-Light Body Quick).
For the 1-step technique with Express™ 2 Penta™ Putty we recommend a wash material with a higher viscosity (Express™ 2 Light Body *Standard*). Low viscous wash materials, especially Express™ 2 Ultra-Light Body are more likely to be displaced.

2. Existing Express™ and Dimension™ customers: How do the new Express™ 2 Wash Materials viscosities correspond to the existing Express/Dimension wash viscosities

Express 2 wash materials have a lower viscosity compared to existing Express and Dimension washes. The reason for this shift towards lower viscosities for the Express 2 VPS line is to enable a better flow onto the prepared tooth and into the sulcus, especially for challenging clinical situations (e.g. tight sulcus, deep subgingival preparations).

Express™ 2 Light Body *Flow* (-Quick) is the more fluid version of the 2 new viscosities. It offers an excellent flow to the tooth and gingiva while still retaining sufficient drip resistance. Upon syringing, the material flows very well into the sulcus by itself. Express™ 2 Light Body *Standard* (-Quick) is slightly more viscous so that it stays better at the tooth. It still offers great flow characteristics.

For Express Light Body (-Quick) and Dimension Garant L (-Quick) users who want to stay with their viscosity we recommend to use Express™ 2 Light Body *Standard*, which is closest to their existing products.

3. Are Express™ 2 VPS Impression Material compatible with other 3M ESPE VPS impression materials (Dimension™, Express™ and Imprint™ II products)?

From a chemical perspective all Express 2 products can be combined with each other, and with other 3M ESPE VPS impression materials. The individual products may differ in their working and setting times, especially if we talk about regular setting and fast setting products. In case two products with different working times are combined in the 1-step (simultaneous) impression technique, the working time of the combination is determined by the material with the shorter working time, and the intra-oral setting time is determined by the material with the longer setting time (for exact times see corresponding IFU's).

The ideal combination of tray and wash Express 2 VPS Impression Materials, and other 3M ESPE impression materials also depends on the applied impression technique (as described in FAQ 1).

Differences between the materials may occur for their pouring times (minimum 2 hours after impression taking for all Express 2 and Imprint II products, 30 min for Dimension-, and 30 min for Express products). In case products with different pouring times are combined the minimum pouring time is determined by the material with the longer pouring time.

Finally the product colors may also limit the combination of certain tray and wash material. Not all combinations between Express 2 VPS Impression Materials and existing 3M ESPE VPS offer an excellent color contrast between tray and wash material, resulting in a suboptimal readability.

4. What kind of impression trays are suitable for the Express™ 2 VPS Impression Materials?

All impression trays, full arch, quadrant and dual-arch impression trays generally used for precision impressions are suitable (metal and plastic trays, non-perforated and perforated trays, stock and custom trays). Generally, we recommend the use of rigid trays. In particular for the 2-step technique or when using Express™ 2 Penta™ Putty (in cases when high insertion pressure is applied), flexible trays would bend during insertion of the impression, resulting in uncontrolled distortion after removing the impression from the mouth.

For sufficient adhesion, it is important to apply a thin layer of VPS Tray Adhesive, manufactured by 3M ESPE, 5 – 15 minutes before you intend to fill the tray. Dual-arch trays also require application of tray adhesive onto all surfaces, including the gauze, that are in contact with the impression material.

5. What is the cause of smeary impression surfaces in the preparation area?

Such smear layers are an indicator that the impression material has not set properly. Primary reason is contact with chemicals, e.g. sulphur from latex gloves, acrylate and methacrylate residues that inhibit polymerization.
Such effects are often not seen until casting, where adhesion of plaster to the impression or the adhesion of impression material to the plaster cast can occur. We recommend the following precautions to avoid such effects:

Cause	Solution
• Placement of a composite restoration or composite core build-up material just performed	▸ Finish, clean, isolate restoration or core build-up materials
• Temporary restoration produced directly before precision impression taking	▸ Clean affected teeth surface with solvents, e.g. orange oil, isopropyl alcohol, ethanol and cotton swab ▸ to best avoid inhibition caused by temporary restoration materials take the precision impression before fabricating the temporary.
• Not all traces of retraction solutions removed	▸ Carefully remove retraction solution using water spray
• Use of Latex gloves ▸ sulphur form gloves transferred to either retraction cord, impression material, teeth or soft tissue	▸ Check Latex gloves for compatibility or use nitrile gloves which are recommended for VPS material
• Use of surface anaesthetic containing adrenaline	▸ Ask patient to rinse out well
• Contact with C-silicones, e.g. when blocking off	▸ Use VPS or light-cured plastic for blocking off

6. Reasons for poor bonding of Wash Material to the Tray Material

Cause	Solution
• Classes of materials not compatible	▸ Do not combine Express™ 2 products with C-silicones, alginates, hydrocolloids and polyethers
• Temporary restoration was produced directly before precision impression taking, or precision impression was also used as temporary work key	▸ Produce temporary restoration after precision impression has been taken, or create separate temporary work key
• Wash material already in setting phase when tray is seated	▸ Do not exceed working times for tray and wash materials
• 2-step technique only: preliminary impression was not clean enough	▸ Carefully clean preliminary impression with warm water, and dry it afterwards

7. Does the working time of the materials depend on the temperature?

Like all VPS the working time for the Express™ 2 VPS Impression Materials depend on temperature. At room temperatures above 25° C, the working times for all Express 2 products is much shorter compared to the values given in the IFU. The shorter working time may reduce syringing of the typical amount of prepared teeth with the impression material. Also the whole impression taking procedure becomes rushed.

For such hot days we recommend storing the Express 2 VPS Impression Materials in the refrigerator at 8° C – 10° C and placing them into the warm operatory approximately 1 hour before impression taking. We strongly advise against mixing the paste in the Pentamix™ 2 Mixing Unit directly after removal from the refrigerator without warming it up beforehand. The higher viscosity of the cold paste (<18° C) will increase the dispensing forces, causing heavy wear on the Pentamix unit, especially when Express™ 2 Penta™ Putty is used.

8. How to avoid the formation of voids in the plaster model

The most common reasons for the formation of voids in the plaster model are:

- Casting the impression too early and
- Excessive surface tension of the impression

Voids will form if casting is carried out too early. This is due to the release of hydrogen gas into the surface of the plaster from the polymerization reaction of the molecules. This chemical reaction is completed in about 2 hours after impression taking. On cooler days or environment, this may take longer.

The surface tension of silicone impressions can be reduced by the use of silicone wetting agents applied shortly before casting.

9. Pentamix™ 2 Mixing Unit: Tips and Tricks for Pentamix first time users

a) General questions on the Pentamix 2 Mixing Unit

Pentamix™ 2 Mixing Unit: What to do when …	Cause	▸ Solution
Unit does not start	Plunger is in bottom or top position	▸ Turn plunger away from bottom or top position by using adjustment knob
Paste not dispensed	• Cartridge is empty	▸ Insert new foil bags
	• Foil bag openings glued up with cross-contaminated impression material	▸ Clean foil bag openings
	• Plunger is blocked	▸ Check that handwheel moves freely
Unit does not switch off	Start button is jammed	▸ Press start button again, if necessary remove mains plug and release start button
Paste flows too slowly or not at all	Paste temperature too low	▸ Bring up to room temperature, min. 18° C
Cartridge cannot be inserted into unit	• plungers not in top position	▸ Move up plungers by turning handwheel clockwise as far as it will go and hold.
	• Cartridge locking lever not closed	▸ Close cartridge locking lever
Initially dispensed material not homogeneous in color	There has been a minimal change in the length of the foil bags through the cartridges being stored vertically outside the unit	▸ Store cartridges horizontally ▸ Always check mixing quality for a uniform color typical of paste
Material not homogenously mixed	Penta™ Mixing Tip not properly fastened onto drive shaft ▸ rotor inside the Penta™ Mixing Tip not turning	▸ Attach new Penta™ Mixing Tip after cartridge is placed inside the Pentamix™ Mixing Unit ▸ Push Penta™ Mixing Unit onto drive shaft and then into corresponding holes in the cartridges. If necessary, rotate mixing tip on drive shaft for proper seating.

b) Questions related only to Express™ 2 Penta™ Putty

Pentamix™ 2 Mixing Unit: What to do when…	Cause	▸ Solution
Penta™ Mixing Tip gets warm so that the working time of the impression material is shortened	The unit operated a long time without impression material being dispensed, because:	
	• a new foil bag was opened	▸ In case a new foil bag is opened, don't release the Pentamix™ 2 Mixing Unit's activation button after paste is dispensed in a uniform color, but immediately load tray
	• The plunger was not in contact with the foil bag when activation button was pressed	▸ Before pressing the Pentamix 2 Mixing Unit's activation button turn down handwheel until plunger is in contact with foil bag.
	• The tray filling procedure was interrupted by releasing and pressing again the Pentamix Unit's activation button while the tray was loaded	▸ Load the tray in a single operation without releasing the Pentamix 2 Mixing Unit's activation button

10. Can Express™ 2 Penta™ Putty foil bags be used with the plastic Penta™ Cartridges?

"No"

Due to the high viscosity of the paste/putty, greater forces are exerted on the cartridge walls while expressing the Express™ 2 Penta™ Putty material compared with other 3M ESPE Penta™ Impression materials.
The former plastic Penta™ Cartridges, which still can be found in many dental offices, will expand at the wall sides when subjected to increased pressure, possibly causing the foil bag to become jammed between the cartridge and plunger. This would make it difficult or even impossible to turn back the plunger or adjustment knob. Or, it may deliver the jammed paste too slowly or not at all, resulting in poor mixing quality. In the long term the plastic cartridges would not withstand the high stresses and would break.

Only use Express™ 2 Penta™ Putty with 3M™ ESPE™ Penta cartridges equipped with inner tubes made of steel. These Penta cartridges do not expand laterally and will prevent damage to the Penta unit, and or poor mix quality of the impression material as described.

Summary

With the Express™ 2 VPS line 3M ESPE has set a new standard for precision impressioning.
The new products set the stage for uncompromising impression quality, the prerequisite for excellent fitting restorations – the best basis for a good relationship between dentist, patient and dental technician.

Express 2 products offer all features a state-of-the-art impression material must have to exactly capture the intra-oral situation in all aspects, and also to remove the impression without distortions. This has been realized by a series of excellent properties the new materials offer:

- very high hydrophilicity
- excellent flow characteristics
- high elongation potential
- very high tensile strength
- very high toughness
- excellent recovery from deformation (elongation, compression)

All these properties taken together make Express™ 2 a VPS Impression Material with an outstanding balance of clinically relevant properties – the key factor for clinical success under any clinical conditions.

Bibliography

T. Noack, M. Balkenhol, P. Ferger, B. Wöstmann
Klinisch erreichbare Abformgenauigkeit von A-Silikonen
Deutsche Zahnärztliche Zeitschrift 59 (2004)

Aimjirakul P., Masuda T., Takahashi H., Miura H.
Gingival sulcus simulation model for evaluating the penetration characteristics of elastomeric impression materials
Int J Prosthodont. 2003 Jul-Aug;16(4):385-9

C. S. Petrie, M. P. Walker, A. M. O'Mahony, P. Spencer
Dimensional accuracy and surface detail reproduction of two hydrophilic vinyl polysiloxane impression materials tested under dry, moist, and wet conditions
J Prosthet Dent 2003; 90:365-72

A. Siemer, M. Balkenhol, M. Trost, P. Ferger, B. Wöstmann
Abformgenauigkeit von Doppelmischabformungen vs. Korrekturabformungen – eine 3D-Scan In-vitro-Studie
Dtsch Zahnärztl Z 59 (2004) 10

M. B. Blatz, A. Sadan, J. O. Burgess, D. Mercante, S. Hoist
Selected characteristics of a new polyvinyl siloxane impression material – a randomized clinical trial.
Quintessence Int. 2005 Feb;36(2):97-104

S. Y. Chen, W. M. Liang, F. N. Chen
Factors affecting the accuracy of elastometric impression materials
J Dent. 2004 Nov;32(8):603-9

J. Zech, H. Hoffmann, S. Hader
Elastic recovery after elongation of VPS impression materials
Poster presentation at AADR 2006, Orlando

J. Zech, H. Hoffmann, S. Hader
Toughness of different VPS impression materials
Poster presentation at CED 2005, Amsterdam

C. Wiedig, J. Zech, F. Strauss
Hydrophilicity of fast setting VPS precision impression materials
Poster presentation at CED 2005, Amsterdam

B. Gangnus, J. Fetz, M. Harre, E.-M. Popp, J. Zech
Intraoral insertion forces of VPS tray materials – Part I: Method
Poster presentation at CED 2005, Amsterdam

V. Porsfeld, C. Wiedig, J. Fetz, J. Zech, E.-M. Popp
Intraoral insertion forces of VPS tray materials – Part II: Comparisons
Poster presentation at CED 2005, Amsterdam

S. Hader, J. Zech, H. Hoffmann, V. Porsfeld
Influence of curing methods on tensile strength of impression materials
Poster presentation at IADR 2006, Brisbane #2069

J. Nam, A.J. Raigrodski, J.D. Townsend, X, Lepe, L. Mancl
Assessment of mixing techniques for polyvinylsiloxane materials of two viscosities
Poster presentation at IADR, 2006, Brisbane #1557

P. Ferger, B. Wöstmann, M. Balkenhol
Werkstoffkundliche in-vitro Untersuchung eines neuen knetbaren A-Silikons für ein dynamisches Mischgerät (unpublished data)

Physical/Technical Data

		Tray Materials				Wash Materials						
Property	**unit**	**Express™ 2 Penta™ Putty**	**Express™ 2 Penta™ H**	**Express™ 2 Penta™ H Universal Quick**	**Express™ 2 Penta™ H Quick**	**Express™ 2 Light Body *Flow***	**Express™ 2 Light Body *Standard***	**Express™ 2 Regular Body**	**Express™ 2 Light Body *Flow* Quick**	**Express™ 2 Light Body *Standard* Quick**	**Express™ 2 Regular Body Quick**	**Express™ 2 Ultra-Light Body Quick**
Consistency A+B (ISO 4823:2000)	mm	34	31	33	32	42	40	38	42	39	39	46
Linear dimensional change (ISO 4823:2000)	%	– 0,3	– 0,3	– 0,2	– 0,3	– 0,3	– 0,3	– 0,4	– 0,3	– 0,4	– 0,4	– 0,3
Recovery from deformation (ISO 4823:2000)	%	99,4	99,5	99,6	99,5	99,8	99,7	99,7	99,8	99,7	99,7	99,6
Strain in compression (ISO 4823:2000)	%	2,0	1,8	2,4	1,3	4,1	4,0	4,1	4,1	3,9	4,3	3,9
Tensile strength at mouth removal (3M ESPE AG internal)	MPa	–	–	–	–	4,45	4,81	4,43	4,71	4,59	4,11	3,49
Toughness at mouth removal (3M ESPE AG internal)	J	–	–	–	–	1,01	1,18	1,19	1,14	1,09	1,21	0,77
Recovery from elongation at mouth removal (3M ESPE AG internal)	%	–	–	–	–	0,34	0,25	0,33	0,32	0,33	0,29	0,20
Shore hardness after 15 min (DIN 53504)	–	76	69	72	68	51	52	51	51	53	50	52
Shore hardness after 24 min (DIN 53504)	–	78	74	76	72	54	56	56	54	57	55	57
Contact angle after 2 sec., cured (3M ESPE AG internal)	°	–	37	–	37	11	18	29	9	19	36	–
Contact angle after 10 sec., cured (3M ESPE AG internal)	°	–	9	–	10	–	–	–	–	–	–	–

Compatibility with gypsum (ISO 4823:2000) and reproduction of detail (ISO 4823:2000) are fulfilled for all tray and wash materials
Note: The data do not represent ranges of values but are individual values, each relating to a specific production batch.

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