3M ESPE

# Lava™

## All-Ceramic System

## Technical Product Profile

# Table of Contents

# Introduction

## Overview

The Lava™ All-Ceramic System from 3M ESPE comprises a CAD/CAM procedure for the fabrication of all-ceramic crowns and bridges for anterior and posterior applications. The framework ceramic consists of zirconia supplemented by a specially designed veneer ceramic. The frameworks are fabricated using CAD/CAM procedures (scanning, computer-aided framework design and milling) from pre-sintered zirconia blanks. High-strength restorations with excellent fit are produced by the system, the size of which has been increased to compensate for shrinkage during sintering in a special high-temperature furnace.

*Figure 1.*
*Lava Scan Optical 3D Scanner*

*Figure 2.*
*Lava Form Computer-aided Milling Machine*

*Figure 1*

*Figure 2*

*Figure 3.*
*Lava Therm Sintering Furnace*

*Figure 4.*
*Lava Frame Zirconia Framework*

*Figure 3*

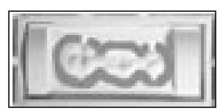


*Figure 4*

## History

Porcelain restorations have been a fundamental component of dental care for many years. Reports dating from the seventeenth century recount the first successful attempts of a porcelain tooth replacement[1] (Duchateau and Dubois de Chemant, Paris).

At the beginning of the nineteenth century Charles Henry Land developed the porcelain jacket crown, based on a feldspathic composition, which is still used today in a slightly modified form. Fifty years later, reinforcement of the jacket crown with aluminium oxide was achieved as a result of the work of McLean and Hughes.[2]

Further materials developments, which concentrated on the inadequate fracture resistance of the shell ceramics, were based on increasing the crystalline content, for example leucite (Empress®), mica (Dicor®), hydroxyapatite (Cerapearl®) or mixed glass infiltrated (e.g. aluminum/ magnesium/zirconium) oxides (In-Ceram®).

*Figure 5.*
*Glass ceramic*
*(contains glass)*
*e.g. Empress I/II Ceramic*

*Figure 6.*
*Infiltrated ceramic*
*(contains glass).*
*e.g. In-Ceram Ceramic*

*Figure 7.*
*Polycrystalline ceramic*
*(glass-free e.g. Lava Ceramic)*

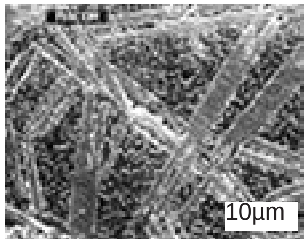


*Figure 5*

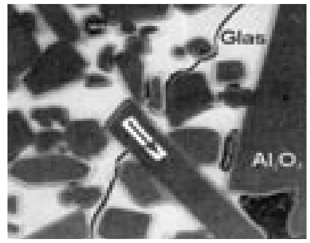


*Figure 6*

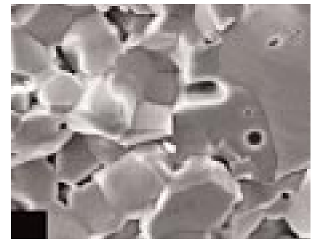


*Figure 7*

Pure polycrystalline oxide ceramics (e.g. Procera®) have only been in clinical use for about 10 years.

Casting (Dicor®), pressing (Empress®) and grinding techniques (CEREC®) are all used to create morphology.

The idea of using CAD/CAM techniques for the fabrication of tooth restorations originated with Duret in the 1970s. Ten years later Mörmann developed the CEREC-system first marketed by Siemens (now Sirona), which enabled the first chairside fabrication of restorations with this technology. There has been a marked acceleration in the development of other CAD/CAM laboratory systems in recent years as a result of the greatly increased performance of PCs and software.

Pressed ceramics, such as Empress have been used successfully for anterior crown applications for more than 10 years. In-Ceram crowns have also been used with long-term success for *anterior* tooth applications, though In-Ceram bridges and fixed partial dentures in *posterior* applications have not. In view of the success of porcelain fused to metal for over 30 years, any new all ceramic system must have longevity comparable to this. A minimum survival rate of 85 % after 10 years in situ is required - even for posterior teeth.[2a]

Crowns luted utilizing adhesive bonding have initially had favorable conditions for a high survival rate. Adhesively bonded, glass containing restorations help disperse stress throughout the restoration/tooth structure system. The first published clinical results on Empress II are promising for bridges only up to the first premolar, but again long-term results are not yet available.

## Motivation

As a result of the requirement to provide patients with excellent esthetic and biocompatible prosthetic dental restorations, the search for ways to fabricate all-ceramic multi-unit bridges, offering long-term stability in posterior applications, has witnessed the limitations of glass ceramics and infiltrated ceramics.

Because of their material characteristics, polycrystalline ceramic frameworks are able to surmount these limitations. Bridges for the posterior region are also considered as an indication. It is zirconium oxide (zirconia), with its excellent strength and biocompatibility known from implant prosthetics, that provides suitability as the framework material of choice. This type of framework can be fabricated by an automated process which supplies constant, monitored high quality, and is designed to be as versatile (in materials/indications) as possible.

The high strength and natural esthetics of the framework mean that less tooth structure is removed during clinical preparation. Traditional cementation techniques, as used in luting porcelain fused to metal, are possible.

#### Biocompatibility

All-ceramic tooth restorations are considered inert with respect to oral stability and biocompatibility. The accumulation of plaque is comparable to that of the natural tooth. Due to the low thermal conductivity of the ceramic, (unlike metal-supported units), sensitivity to temperature variation is not anticipated.

#### Long-term stability

The main concern centers on adequate long-term strength under functional stress in the specified range of indications. From the clinical point-of view, it is not the initial strength of the ceramic material itself that is of prime importance, but the longevity of the permanent restoration. In the case of ceramics containing glass, the type of cementation, adhesive bonding or conventional, may be a decisive factor. It has a considerable effect on the stresses acting on the entire tooth preparation/restoration system. For the clinical use of all porcelains with a flexural strength of around 100 MPa and fracture toughness < 2 $MPa \cdot m^{1/2}$ (typical for glass ceramics), adhesive bonding is required. In the case of polycrystalline ceramic frameworks with considerably higher strength values, conventional cementation using glass ionomer cement may be recommended. Zinc phosphate cement is not indicated for esthetic reasons.

The lack of long-term strength (subcritical crack growth, fatigue, stress, corrosion) for ceramic systems containing glass already on the market, when subjected to the masticatory forces occurring in the mouth, is problematical. There is more noticeable loss of strength with glass containing systems due to the effect of oral moisture and subcritical crack propagation (decreases to < 50% of initial strength). To guarantee successful, long-term muti-unit bridge restorations, an initial strength of more than 400 N is required for anterior restorations and more than 600 N for posterior applications. Currently, values such as these (final strength of at least 500 N) are currently achieved only with alumina or zirconia bridges.[2b]

#### Traditional Working Method

Ideally, the laboratory's dentist/customer needs a system that does not require him/her to change preparation and/or impressioning methods. The optimal system would use supragingival preparations where less tooth structure is removed, as compared with porcelain fused to metal restorations. Traditional luting, e.g., glass ionomer cement, would simplify the cementation process - and have the advantage of many years of success.

#### Range of indications

In modern clinical/materials scientific literature, currently available all-ceramic systems (e.g. Empress® and In-Ceram®) are seen as being suitable for crowns in anterior and some posterior applications. Anterior bridges are indicated, but posterior bridges may be suitable only as far back as the first premolar (e.g. Empress® II).[4] Clearly, a need for a reliable all-ceramic system designed for use in all posterior as well as anterior situations is needed.

### Reliability

The literature describes other ceramic - specific parameters, such as fracture toughness and Weibull modulus. The Weibull modulus indicates the distribution of strength values. A high Weibull modulus (> 10) reflects a close distribution and is therefore advantageous, especially if strength is low. However, for safety reasons a high Weibull modulus should be the goal even if there is high strength.

### Accuracy of fit

Good accuracy of fit is also a determining factor for clinical success. An accuracy at the crown margin of 50 µm - 100 µm is considered ideal. A clear definition of the term fit is important (Holmes et. al[13]).

### Result

These requirements can now be achieved using precise scanning and milling technologies - coupled with accurate knowledge of zirconium oxide ceramics. 3M ESPE’s Lava™ system has been developed utilizing the accumulated knowledge of previously available materials and systems, and newly developed state-of-the art scanning and milling expertise - to provide the laboratory, dentist, and patient with the most durable and esthetic all - ceramic restorations available today.

# Indications

Due to its outstanding mechanical and optical properties, Lava™ System materials cover a wide range of crown and bridge applications for most anterior and posterior prosthetic requirements.

*Figure 8*
*Lava system anterior crowns*

*Figure 9.*
*Lava system posterior crown*

*Figure 10.*
*Lava system anterior bridge*

*Figure 11.*
*Lava system posterior bridge*

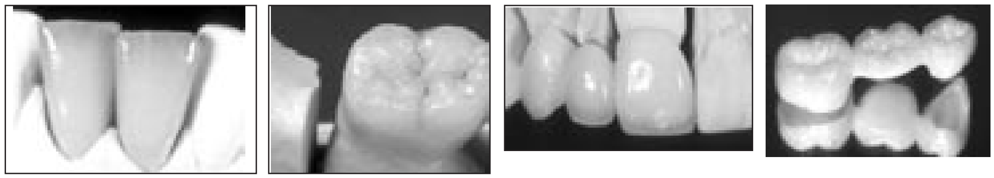


*Figure 8, 9, 10, 11*

## Preparation

The optimal preparation is a shoulder or chamfered preparation with a circumferential step or chamfer which must be applied at an angle of > 5º (horizontal). The angle of the preparation (vertical) should be 4º or larger.

*Figure 12.*
*Chamfered preparation*

*Figure 13.*
*Shoulder preparation with rounded inside angle*

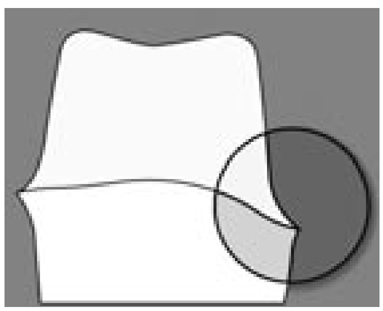


*Figure 12*

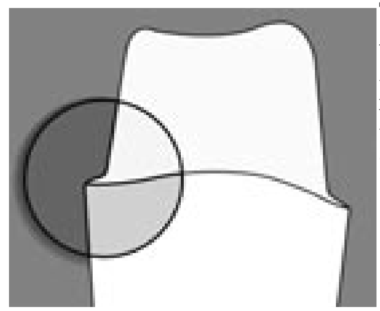
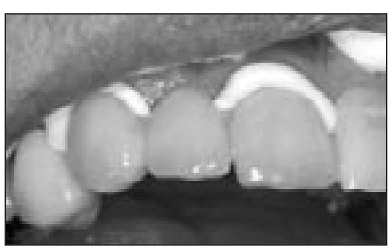


*Figure 13*

The inside angle of the shoulder preparation must have a rounded contour.

*Figure 14.*
*Cementation of an anterior bridge with Ketac™ Cem Luting Cement before the removal of excess material*



## Cementation

Traditional cementation with 3M ESPE Ketac™ Cem or RelyX™ Luting Cement, for example, is recommended for cementing crowns and bridges made from Lava system materials for every restoration type.

# Materials Science Background

## General Overview

The general term all-ceramic dental materials covers various oxide ceramic with very different material properties.

In addition to glass ceramics (reinforced by crystalline regions), two other types available are glass infiltrated and polycrystalline ceramics.

The first two groups are multi-phase materials and contain crystalline constituents (e.g. leucite crystallites) in addition to an amorphous glass phase.

Alumina and zirconia are the only two polycrystalline ceramics suitable for use in dentistry as framework materials, able to withstand large stresses in both anterior and posterior areas. These materials are shown to provide the necessary esthetic (tooth shade, opacity/translucency) and materials properties required of a modern tooth restoration.

Literature[6,7] indicates that 3-unit posterior bridges are clinically acceptable due to the high fracture toughness of In-Ceram® zirconia, as recommended by the manufacturer Vita™. It must be noted however, that finishing of sintered ceramics induces micro-defects. The introduction of defects during fabrication may lead to a noticeable loss of strength even with high strength systems. In particular, the phenomenon of subcritical crack growth results in a poorer long-term prognosis for finished ceramic restorations. Generally speaking, the long-term strength of ceramic systems containing glass cannot be classified as risk-free.

The question of long-term stability, which is highly dependent on subcritical crack propagation and fatigue is an exceptionally important aspect in the assessment of new all-ceramic systems. Subcritical crack propagation refers to a continous fracture process in ceramics subjected to static and/or dynamic stress, whereby the crack may grow at a certain rate, until it results in a complete failure. The speed of crack growth also depends on the surrounding medium as well as the previously mentioned fracture toughness. $H_2O$ in the saliva leads to so-called stress corrosion in systems containing glass. The water reacts with the glass causing decomposition of the glass structure; this leads to increased crack propagation velocities and consequently to long-term strength issues. On the other hand, systems having a polycrystalline microstructure such as $ZrO_2$ or $Al_2O_3$, and are to a great extent glass-free, display excellent long-term stability (see Properties and References).[6,7]

The preparation geometry and wall thickness of framework and veneer ceramic are also decisive factors with regard to the strength of the permanent restorations. In the case of In-Ceram a chamfered preparation and framework wall thickness of around 0.8 mm is required for an optimal result. In the case of Empress®, the requirements are 1 mm of reduction in the body of the preparation and the shoulder. Lava™ Frame frameworks demonstrate the required strength at an overall thickess of only 0.5 mm.

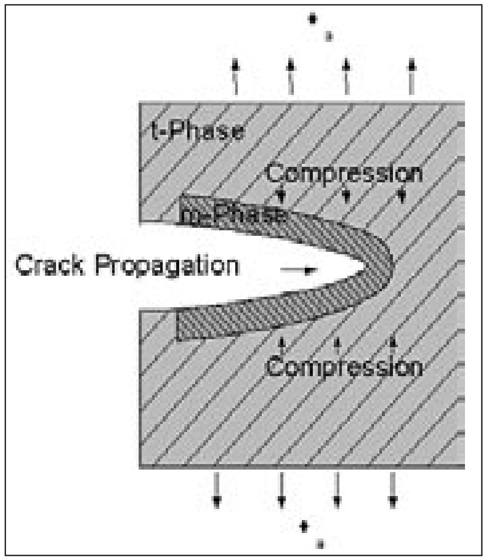



*Figure 15.*
*Fracture inhibition due to tetragonally stabilized Zirconia.*

**Materials Science Aspects**

Zirconium Dioxide used in demanding environments is usually a tetragonal polycrystalline Zirconium Dioxide partially stabilized with Yttria (Y-TZP = yttria-tetragonal zirconia polycrystals) (addition of about 3 mol per hundred). This structure is referred to as a transformation toughened material and has the special property of inhibiting fractures. Tensile stresses acting at the crack tip induce a transformation of the metastable tetragonal zirconium oxide phase into the thermodynamically more favorable monoclinic form. This transformation is associated with a local increase in volume. This results in localized compressive stresses being generated at the tip of the crack, which counteracts the external stress acting on the crack tip. This leads to a high initial strength and fracture toughness and, in combination with a low susceptibility to stress fatigue, to an excellent service life prognosis for Zirconium Dioxide frameworks.

The frameworks may be fabricated by grinding dense sintered blanks (e.g. DCS®, Celay®) or by milling pre-sintered porous Zirconium Dioxide blanks (e.g. Lava™ System). In the latter case, the sintering shrinkage is compensated for with the aid of powerful software.

Because of the relatively low coefficient of thermal expansion (CTE) of Zirconium Dioxide (approx. 10 ppm), a special veneering ceramic (with the matched CTE) must be used in order to keep the sintered ceramic under slight compression.

In-vitro trials confirm the high fracture strength of veneered 3-unit Zirconium Dioxide posterior bridges.[8] Resistance greater than 2000 N has been achieved, which exceeds the maximum masticatory load by a factor of 4. With this strength, bridges of this type demonstrate markedly better values than other all-ceramic bridges (e.g. Empress® II : 650 N, In-Ceram® Alumina at 800 N). Consequently, Zirconia can be considered as a suitable framework material for multi-unit bridges.

The strength values and high fracture toughness (resistance to crack propagation $K_{IC}$ about 10 MPa $m^{1/2}$ compared to aluminium oxide at about 5 MPa $m^{1/2}$) also enables lower framework thickness than other all-ceramic systems previously available. Instead of a coping thickness of 1 mm, a Lava framework/coping thickness of 0.5 mm is considered adequate. This permits preparation which encourages less agressive tooth reduction than is the case with most systems currently on the market. The excellent esthetics of the zirconia framework (ideal translucency and coloration, see below) also enables the thickness of the veneer layer to be minimal, a result of which is a possible conservative preparation technique similar to porcelain fused to metal is possible.

The surface finishing of ceramic materials has a decisive effect on the material's flexural strength. The grinding and milling of sintered ceramics usually leads to a reduction in strength (micro-defects on the surface). The finishing, by grinding or milling, of sintered zirconia frameworks (either by means of the fabrication process, such as DCS, or finishing in the dental laboratory) may lead to a loss of strength compared to finishing in the green, or pre-sintered state (Lava™ system, 3M ESPE techniques). The finishing of sintered frameworks using grinding or milling tools is contra-indicated in the connector area. (enhanced tensile stress). The milling procedure sufficiently 'roughens' the internal aspect of the crown for retention of cement.

If adhesive bonding is desired, it must be accomplished with the aid of 3M ESPE's Rocatec™ Bonding System or Cojet™ Bonding Systems, which add a silicate coating to the internal aspect of the framework, followed by a dual cure bonding resin, such as the RelyX™ ARC Adhesive Resin Cement.

Zirconia posterior bridges fabricated according to procedures similar in Zurich have been in use in a clinical trial since 1998. Results so far are extremely positive.[9a, 9b]

# Properties

## Overview

Zirconium Dioxide has proven itself as a biocompatible material in implant surgery since the 1970's. The Lava System with Frame zirconia demonstrates no measurable solubility or water absorption. Therefore the strength of this material even after a long period in the mouth is expected to be excellent. The Lava system with Frame zirconia has no allergenic potential and is very biocompatible and Lava system with Ceram veneer ceramic has all the familiar advantages of a feldspathic veneer ceramic with respect to biocompatibility and abrasion characteristics.

Zirconia withstands many times the level of stress occurring in the mouth (loads measured for: anterior teeth up to 250 N, posterior teeth up to 450 N). Its strength is considerably higher than other all-ceramic materials. Unlike infiltrated or glass ceramics, the Lava system with Frame zirconia is particularly suitable for posterior bridge frameworks.

## Mechanical Properties

### Material Specifications

***Lava™ Frame framework ceramic***

| | |
|---|---|
| Density (ρ): | 6.08 g/cm$^3$ |
| Weibull strength (σB): | > 1200 MPa |
| Fracture toughness ($K_{IC}$): | 10 MPa m$^{1/2}$ |
| (Youngs) Modulus of elasticity (E): | 210 GPa |
| CTE: | 10 x 10$^{-6}$ 25-500°C |
| Melting point: | 2700°C |
| Grain size: | 0.5 µm |
| Vickers hardness (HV 10): | 1250 |

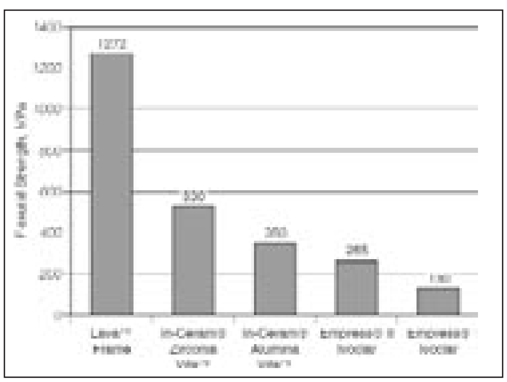
***Lava™ Ceram veneer ceramic***

| | |
|---|---|
| Density (ρ): | 2.5 g/cm$^3$ |
| Weibull strength (σB): | 95 MPa |
| Fracture toughness ($K_{IC}$): | 1.2 MPa m$^{1/2}$ |
| (Youngs) Modulus of elasticity (E): | 80 GPa |
| CTE: | 10x10$^{-6}$ 25-500°C |
| Firing temperature: | 810 °C |
| Grain size ($d_{50}$): | 25 µm |
| Vickers hardness (HV 0.2): | 530 |

*Data in accordance with standard ISO 6872*

### Material Specifications - Lava Frame framework ceramic

***4-point bending test (biaxial: piston-on-three-balls)***

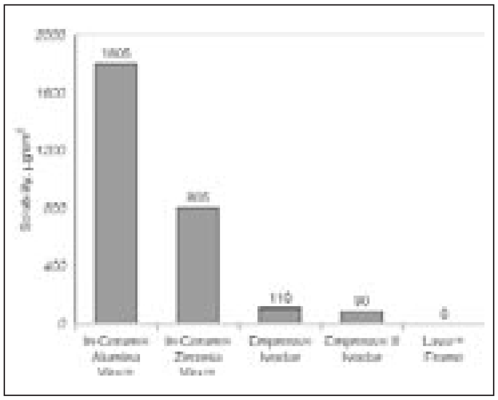



A competitive product, In-Ceram® Zirconia, which is a glass-infiltrated ceramic based on a zirconium oxide and aluminium oxide combination, has only about half the flexural strength of Lava System Frame, but has been indicated for bridges in posterior applications.

The flexural strength (ISO 6872) in the 3-point bending test was also determined by Dr. Simonis (Berlin)[10]: 1625 MPa.

*Data in accordance with standard ISO 6872*

### *Chemical Solubility*

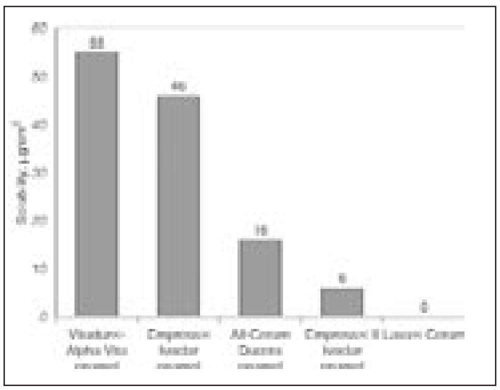


The fact that there is no detectable solubility of the Lava™ zirconium oxide framework is an indication of its high biocompatibility.

*Data in accordance with standard ISO 6872.*

## Material Specifications - Lava Ceram veneer ceramic

### *Chemical Solubility*



As with the framework ceramic, here too the solubility cannot be measured. This is an indication of excellent biocompatibility.

## Long-term strength

*Table 1: Characteristic material values of various dental ceramics*

| Ceramic | Weibull strength $\sigma_0$ [MPa] | Weibull modulus m [ - ] | Fracture toughness $K_{IC}$ [MPa√m] | Crack growth coefficient n [ - ] | Crack growth coefficient B [$MPa^2$sec] |
|---|---|---|---|---|---|
| Lava™ System Frame | 1345 | 10.5 | 9,6 | 50* | - |
| In-Ceram® Alumina | 290 | 4.6 | 5 | 18 | $6.0 \cdot 10^1$ |
| CEREC® (Vita™ Mark II) | 88 | 24 | 1.3 | 26 | $1.8 \cdot 10^1$ |
| Dicor® | 76 | 6 | 0.8 | 25 | $2.9 \cdot 10^1$ |
| Empress® I | 89 | 9 | 1.2 | 25 | $5.8 \cdot 10^1$ |
| Empress® II | 289 | 9 | 2.5 | 20 | $2.3 \cdot 10^3$ |
| HiCeram® | 135 | 9 | 2.5 | 20 | $1.2 \cdot 10^3$ |
| Hydroxyapatite | 114 | 6 | 0.9 | 17 | $2.2 \cdot 10^2$ |
| Vita™ Omega Opaker | 69 | 12 | 1.4 | 21 | $7.2 \cdot 10^1$ |

*Prof. Marx and Dr. Fischer, Aachen.*[19]
** = 3M ESPE internal data*

### Estimate of long-term strength of the Lava™ System Frame

*(peripheral conditions: 60 % atmospheric humidity, 22°C, static continuous load)*

A mathematical estimate of the service life time (maximum static continuous loading, with 2% failure rate after 5 years) can be made using a so-called SPT diagram (SPT: Survival-Probability-Time):

*Table 2:*
*Long-term flexural strength (static continuous load)*

| | Lava™ System Frame | Empress® II | In-Ceram® Alumina | Vita™ Mark II |
|---|---|---|---|---|
| $\sigma_{2\%}$ 5 years [MPa] | 615 | 80 | 125 | 30 |

*Source: Marx and Fischer, Aachen and internal measurements*

The table must be interpreted in the following way: if a Lava System Frame test specimen is subjected to a load of 615 MPa in moisture for 5 years, a failure rate of 2% may be expected. The same failure rate is returned by Empress II under a continuous load of only 80 MPa.

### Strength and Real Geometries

*Fracture strength of 3-unit posterior bridges (patient models) before and after masticatory simulation (Munich, Prof. Pospiech PD, Dr. Nothdurft, Dr. Rountree)[10,11]*

Resiliently mounted after cementation with Ketac™ Cem Luting Cement (mean values of 8 bridges)

a) initially after 24 h: 1800 N SD = 234N

b) after 1.2 million masticatory load cycles (50N) and 10,000 thermocycles (5°/55°C): 1450 N SD = 235N

*Figure 16.*
*Set-up for masticatory simulation and thermocycle*

*Figure 17.*
*Fracture test*

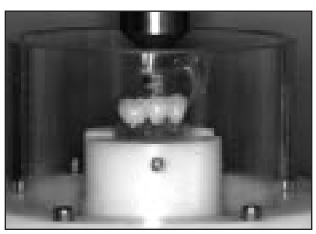


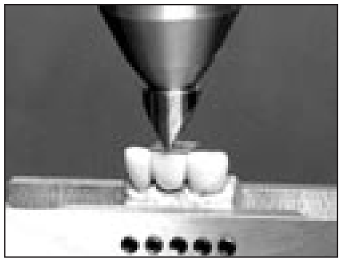
*Figure 16*

*Figure 17*

The slight decrease in the values combined with exceeding the maximum masticatory loading for posterior teeth of approx. 450 N (see above) after simulated 5 years of wear suggests an excellent probability of survival.

*Fracture strength and long-term strength of 3-unit anterior bridges before and after masticatory simulation (Kiel, Prof. Ludwig)[10]*

*Figure 18. Measurement of static fracture load*



Resiliently mounted after cementation with glass ionomer. 6 bridges (11-22) were loaded from an angle of 30° until fracture occurred.

a) Initially (24 h storage in water): static fracture load: 1430 N

b) Long-term strength after masticatory simulation (1.2 million cycles – corresponding in clinical terms to approx. 5 years of wear, at 250 N, incl. thermocycling 5°/ 55°C): no fracture

Prof. Ludwig's conclusion based on the maximum masticatory force on the anterior teeth of 180 N: Lava™ System anterior bridges can be assumed to be clinically resistant to fracture in long term usage.

**Abrasion**

In a masticatory simulator in Erlangen (Lohbauer), hemispheres made from the veneer ceramics under examination were tested against bovine enamel. Lava Ceram was compared with Empress® II and Omega 900® (spherical) against bovine enamel (ground flat), and also Lava™ Ceram against itself.

The analyses were carried out using a scanning electron microscope (SEM) both for the spheres and the specimens, and volumetric surveys were conducted.

The wear values after 200,000 cycles with a load of 50 N and a further 1,500 cycles under thermocycle (5°C and 55°C) also with a load of 50N resulted in a mean wear of $10^{-3}$ $mm^3$ for all veneer ceramics.

Other findings:

- Differences between the individual groups cannot be established to a significant degree.
- The abrasion of two ceramic surfaces in contact is higher in comparison with the bovine enamel.
- The traces of abrasion on the spheres are very slight and lie within the same ranges of size amongst the groups.
- Fractures which can be detected on the bovine enamel samples on the SEM images are natural fractures in the enamel—and are not attributable to the abrasion process.

The Lava Ceram veneer ceramic displays no fundamental differences from other commercially available products examined as far as abrasion is concerned.

## Visual Properties/Esthetics

The Lava™ System Ceram range of veneer ceramics is optimally coordinated to the range of shades which are applied to the Lava System framework. This results in a harmonic color effect and natural blending to the oral environment (adjacent natural dentition).

The ideal translucency results from the material properties and the low wall thickness of the sintered zirconia. No light-absorbent opaquer or opaque dentine layers are necessary for the build-up of Lava all-ceramic restorations.

Moreover, the relatively thin framework permits optimal build-up even in difficult situations. An appropriate selection of unique modifiers rounds off the Lava™ System Ceram range.

The framework can be colored in 7 shades in the Vita™-Classic shade system and is therefore ideal for a natural-looking build-up.

*Figure 19.*
*After the coloring of the framework (the first unit has not been colored)*

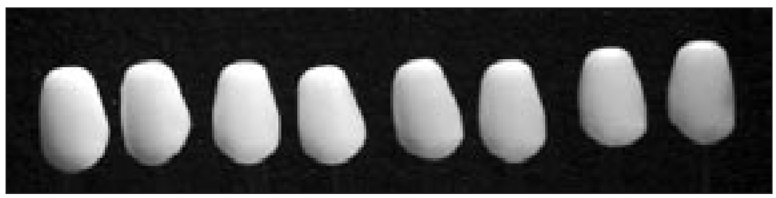
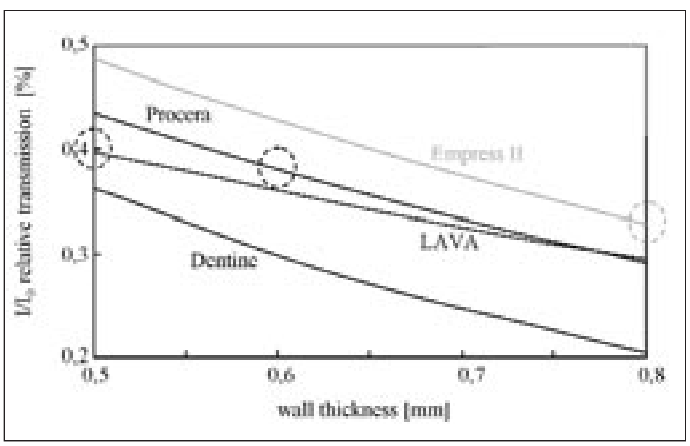


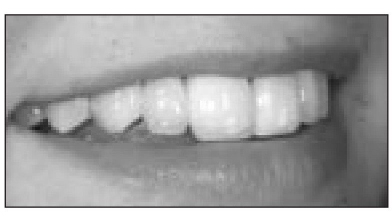
*Figure 20.*
*Comparison of translucency as a function of wall (coping) thickness*




The relative translucency of Lava framework and Empress® II framework is comparable even in view of the wall thicknesses recommended by the manufacturers (Lava: 0.5 mm; Empress II: 0.8 mm).

Any tooth shade can be reproduced without difficulty using the traditional range of 16 shades. Effect material and extrinsic colors provide limitless customization.

*Figure 21.*
*Lava System Anterior bridge from tooth no.s 6-8*



## Accuracy of Fit

Lava™ crowns and bridges have excellent accuracy of fit.

In the Lava System fabrication procedure, the crown or bridge framework is milled from a so-called “green” state. This green blank is made from presintered zirconia and is therefore considerably softer than dense (fully sintered) material. Milling is performed quickly, accurately, and economically before the extreme strength is achieved during the final sintering.

Excellent fit is achieved due to the high milling accuracy and the accurate calculation of the sintering shrinkage via the software package. The cement gap can be adjusted to the individual requirements.

Control of this procedure provides one of the fundamental innovations of the Lava System technique. Specific 3M ESPE technology and sophisticated production processes for the presintered blanks ensure accuracy of fit. The dimensions of the marginal gap easily achieve values comparable to those of porcelain fused to metal.

Studies of marginal gap measurements produced values of 40 µm or 70µm for MO or AMO.[12]

*Figure 22.*
*Light-optical microscope exposure: cross-section of a 3-unit bridge from no.s 18-20*

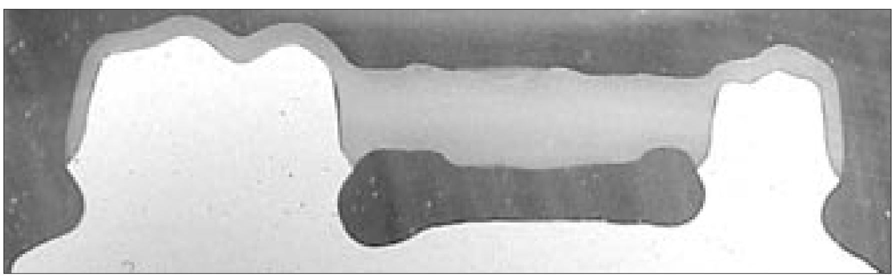
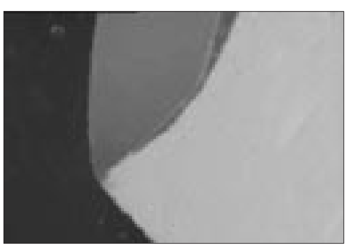


*Figure 23.*
*Detail enlargement buccal*

*Figure 24.*
*Detail enlargement mesial*



MO (marginal opening) can be interpreted as the distance between the framework and the preparation close to the crown margin. AMO (absolute marginal opening) also includes possible contouring work above and below, and measures the distance between the end of the crown margin and the preparation margin.[13]

*Figure 25.*
*MO with under-extension*

*Figure 26.*
*AMO with under-extension*

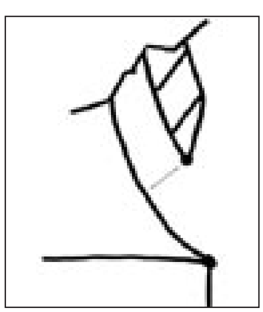


*Figure 25*

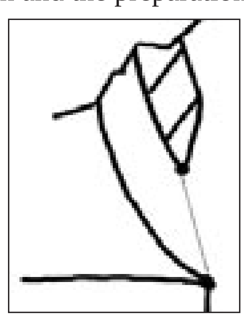


*Figure 26*

### Biocompatibility

Another remarkable feature of zirconia, in addition to its extraordinary chemical stability, is its very high level of biocompatibility. For this reason it has already been in use for more than a decade as a material for surgical implants, such as hip joints. The zirconium oxide utilized, and likewise the veneer ceramic, manifests no measurable solubility or allergic potential, and produces no irritation of the tissue.

The lower thermal conductivity provides comfort for the patient. Moreover, Lava™ System materials do not contribute to galvanic processes in situ.

## Clinical Results

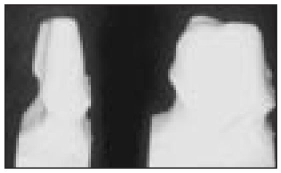
More than 600 cases of fixed dental prosthetic work utilizing Lava system materials were placed between December 1999 and August 2001. In addition to crowns (approx. 500) and anterior bridges (approx. 20), 100 posterior bridges are in situ.

Some patients were treated in 3M ESPE's own dental practice (Seefeld Center). The majority of the clinical work was carried out in various 3M ESPE consultant laboratories and tested on their dentist/clients (40 dentists in total) with very satisfactory results. The esthetics, precision fit, and suitability for simple conventional cementation were found to be particularly impressive.

In addition to this, Dr. Peter Pospiech, senior physician and professor of dentistry at the University of Munich has been conducting a clinical survey according to EN 540 (ISO 14 155) since summer 2000. In this study, 35 patients fitted with posterior bridges are being monitored for a period of 5 years.

*Figure 27.*
*3-unit posterior bridge no.s 29-31 P. Pospiech, University of Munich*

# Technical Overview

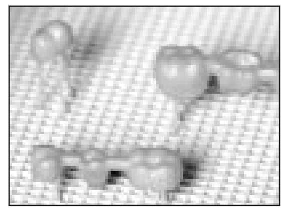


Working model

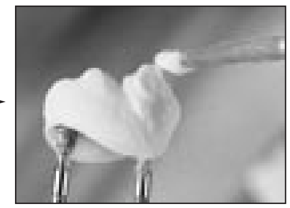
Scanning

Designing

Milling



Sintering



Veneering

### Scanning with Lava™ Scan:

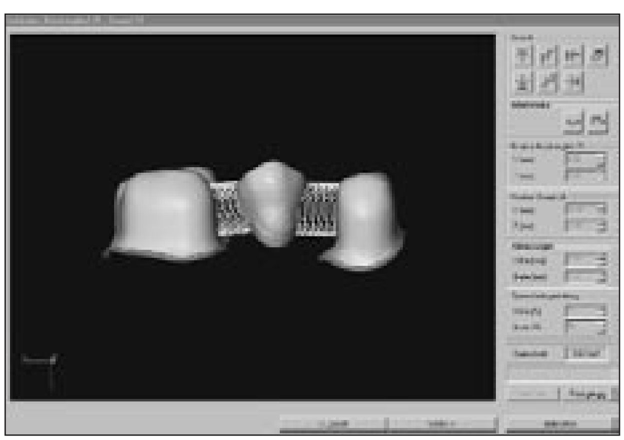
The unit consists of the non-contact, optical scanning system Lava Scan (white light triangulation), a PC with monitor and the Lava CAD software.

When the sectioned model has been positioned in the scanner, individual preparations and the ridge are recorded automatically and displayed on the monitor as a three-dimensional image (recording of the model situation including preparations, gingiva and occlusal record). The preparation margins are scanned and displayed automatically.

### CAD Modelling with Lava™ CAD:

The design of the framework on the screen, e.g. the insertion of a pontic (from a library) or the design/modelling of the connections is done with the keyboard, mouse and software support. No special knowledge is necessary. The data is then transferred to the Lava Form milling unit for calculation of the milling path.

*Figure 28.*
*Design of connectors and pontic on the screen*



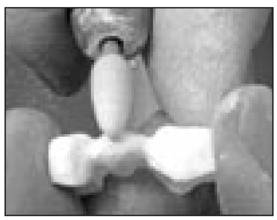
### Milling with Lava™ Form:

The 3D shape is milled from a pre-sintered $ZrO_2$ blank using hard metal tools. The average milling time for a crown is 35 minutes, for a 3-unit bridge about 75 minutes. The machine has a magazine capacity of 20 blanks; new blanks can be inserted and finished frameworks removed while milling continues. Different frameworks can be milled automatically, even overnight, thanks to the automatic tool changer.

### Sintering in Lava™ Therm:

Manual finishing can be carried out before sintering takes place. The coloring of the frameworks also takes place before the sintering process according to the prescribed shade (7 possible shades, keyed to Vita™ Classic). The fully-automated, monitored sintering process then takes place with no manual intervention in a special furnace, the Lava Therm (approx. 8 hours including heating up and cooling phases).

*Figure 29. Manual finishing before sintering*



### Veneering with Lava™ Ceram:

The coefficient of thermal expansion (CTE) of the specially developed, integrated overlay or porcelain ceramic system has been matched closed (-0.2 ppm) to that of zirconia. The 16-shade system is based on the Vita-Lumin range. Very esthetic characterizing possibilities are possible by various additional individual materials. The natural translucency harmonizes ideally with the translucent zirconium oxide framework.

# Instructions for Use

## The Framework Ceramic

**Lava™ Frame**
**Zirconia Blanks for Framework Production with Lava Form**

### Product Description

Lava Frame comprises a selection of Zirconia blanks for fabrication of frameworks for all-ceramic restorations. The blanks are processed in the Lava Form CAD/CAM system. After milling and before sintering, the frameworks are colored with one of 7 available Lava Frame Shade tinting liquids as required to achieve the desired tooth color. The colored frameworks are then sintered using a specialized program in the Lava Therm sintering furnace.

- Please retain these instructions for future use.

### Areas of Application

Precisely fitting all ceramic restorations can be fabricated only when tooth preparation guidelines are followed. For pertinent information, please refer to the "Information for Dentists" section of the Lava system's Instructions for Use.

- Fabrication of all-ceramic crowns and 3-unit bridge frames for anterior and posterior teeth.

### Model Preparation

- A light colored gypsum laboratory stone is recommended for models.
- All segments of the saw cut model must be removable and double pinned to avoid rotation
- An Appropriate holder must be used. Use magnetic base type retention for the working model – do not use indexed casts.
- Dies should be ditched below the margin – DO NOT mark margins or use die spacer and/or hardener on dies.
- Undercuts and defects are blocked out with block-out wax.
- Reflective areas on the abutments are detrimental to the scanning procdure. Use titanium dioxide  spray to 'dull' surfaces of the die. (e.g. Developer D70, Met-L-CHEK).

### Scanning

Crowns and bridges are designed after the scanning-procedure with the Lava Scan computer.

The strength of the restoration and accurate milling results depend on the design of the various bridge elements, the crown margins design, and proper positioning of the sprues.

- When entering data into the Lava™ Scan computer, please observe the design guidelines described in the Operating Instructions of the Lava System!

### Preparation of the Milling Unit

- To mill frameworks with the Lava Form CAD/CAM facility, use burs of type 4 (rough milling), type 5 (finishing), and type 6 (fine-finishing) only; see also Lava Form Operating Instructions.
- Prior to processing Lava Frame frameworks, clean the milling chamber of the Lava Form milling unit. Make sure that no oil remains on or is fed to the cutting spindle and all metal and/or plastic dust is removed.

### Processing After Milling

*NOTE: Dust from grinding may cause eye and respiratory system irritation. Wear protective goggles. Use with appropriate local exhaust ventilation; in situations where local exhaust ventilation is not adequate, wear appropriate respiratory protection.*

In order to prevent contamination, the blank must not be exposed to water or any other liquids or oils during processing!

### Removal of the Milled Framework from the Holding Device

We recommend the use of a high speed air turbine handpiece to remove the framework – due to the lower degree of vibration as compared to other handpieces! If no turbine is available, fine cross-cut tungsten carbide burs can also be used - rotary speed 20,000 rpm.

- First, notch all sprues on their top as close as possible to the crown from the occlusal side and then carefully extend the notches from the opposite side to separate the framework. Use as little pressure as possible in removing the framework from the sprues! Place gently in hand or soft pad! Too much pressure or rough handling may cause damage.

### Finishing of the Blank Surface

Compared to finishing sintered frameworks, shape correction and surface adjustment of the green body (soft-sintered framework) is a more simple and reliable procedure. Adjusting sintered frameworks may cause damage invisible to the naked eye. Sharp corners, edges, joints of the holding pins, and all areas on the surface should be smoothed prior to sintering.

*NOTE: The presence of notches and sharp edges or damage on the bottom side of the interdental connections may substantially reduce the strength of the sintered framework. It is essential to make the framework surface smooth prior to sintering!*

Use Universal Polishers from Brasseler (Type Komet #9557) for finishing only - rotary speed 10,000 - 20,000 rpm!

- Take care not to damage the crown margin when finishing the outer contour in the vicinity of this area.

## Cleaning of the Framework

- Touch the framework only with clean, non-oily hands. The framework surface must remain uncontaminated.
- Thoroughly remove milling dust and debris from the entire surface of the framework, including the internal surfaces of the abutment copings with a disposable applicator. To ensure even coloring, the framework must be clean, free of oils, and completely dry prior to coloring.

## Coloring of the Framework

### *Preparation of the Coloring Liquid/Coloring Process*

All immersion containers for the framework must be dry, clean, and free from (old) coloring liquid to ensure an even shading throughout the framework.

- Select an immersion container that is large enough so the framework will not come in contact with the sides of the container.
- Select the suitable Lava™ Frame shade coloring liquid for the desired tooth shade:

| | 300 ml – bottles | | | | | | |
|---|---|---|---|---|---|---|---|
| Lava Frame Shade Coloring Liquid | FS 1 | FS 2 | FS 3 | FS 4 | FS 5 | FS 6 | FS 7 |
| Coodinates with Vita Classic Colors | A 1<br>B 1 | B 2<br>C 1 | A 2<br>A 3 | A 3.5<br>A 4 | B 3<br>B 4 | C 2<br>C 3<br>C 4 | D 2<br>D 3<br>D 4 |

- Shake up the Lava Frame shade coloring liquid prior to use!
- Pour a sufficient amount of coloring liquid into the container to ensure that the framework is covered by 3 mm of liquid.
- Reseal the bottle immediately after use to ensure that the concentration of the liquid does not become altered.

### *Coloring Process*

- Use plastic forceps to gently place the framework in the container. The framework must be completely covered by the coloring liquid!
- Carefully rock the container to allow any air bubbles trapped inside the coping to escape.
- The immersion time is 2 min. Once this period has elapsed, use clean plastic forceps to remove the framework from the liquid.
- Color each framework only once !
- To ensure even, shading any excess coloring liquid must be blotted from the coping and the connections, e.g. with an absorbent paper towel.
- Make sure that no paper towel remains on the framework.

- After coloring of the framework, place it on a furnace stand for sintering and put it into the furnace.  The sintering process starts only after the furnance door is closed.
- Used coloring liquid is a US EPA hazardous waste. Consult Material Safety Data Sheet for disposal information.

## Sintering of the Lava Framework

### *Positioning for Sintering*

As the Lava framework shrinks by approx. 20-25% (linear) during the sintering process, it is essential to position the framework so that its shrinkage is not restricted during the sintering process. The framework must be positioned so that it cannot tip over and does not touch other adjacent frameworks, and is freely suspended on the pegs so that it does not distort during the sintering process.

- Place the pegs or wires on the honeycomb sintering tray as is required by the framework geometry. The framework must be able to move freely as shrinkage occurs.
- Do not place more than one sintering peg or wire into hole of the honeycomb tray.

### *Positioning of Copings for Sintering*

- Depending on type, use 1 to max. 4 pegs per coping.

| | Number of sintering pegs |
|---|---|
| Anterior tooth | 1 |
| Premolar | 2 |
| Molar | 3 - 4 |

### *Positioning of Bridges for Sintering*

- Position bridges perpendicular to the furnace insertion direction.

### *Anterior Bridges (13-23, 33-43)*

- Always position bridges using one peg per coping.
- The pegs must be positioned close to the walls of the abutment coping nearest the pontic (Mi and Di) without touching them.

### *Posterior Bridges (13-17, 23-27, 33-37, 43-47)*

- Generally position bridges on two wires in the connector area (one per connector).
- Generally position bridges with the occlusal aspect up.

### *Sintering*

For information on the operation of the sintering furnace, please refer to the Operating Instructions of the Lava™ Therm unit!

- For an optimal use of space, the furnace can be loaded with two sintering trays on top of each other. Close the door before pressing “START”.
- Once the Start button is pressed, the sintering program starts up automatically and heats the furnace to 1,500°C/2,732°F. The sintering time is approx. 11 hours. The furnace is automatically unlocked once the temperature drops below 250°C/482°F during the cooling phase of the furnace.

*NOTE: Contact with hot surfaces and material may cause thermal burns. Avoid contact with hot surfaces and material. Wear appropriate insulating gloves when handling hot material. In case of contact, seek medical attention.*

- If the temperature is above 250°C/482°F, do not force the furnace door open since the resulting extreme drop in temperature may damage the furnace and/or the frameworks!
- Use tongs to remove the sintering tray from the furnace. Place the sintering tray on a refractory surface and allow the frameworks to cool down slowly on the sintering tray.

### Veneering

For veneering use Lava Ceram veneer ceramic, a product specifically developed for use with Lava Zirconia framework material. See Instructions for Use of Lava Ceram when processing!

### Cementation

DO NOT roughen the internal surfaces of crowns by mechanical means.

DO NOT use light-curing glass ionomer cements, as water sorption may cause the cement to expand after placement in situ.

For detailed information on the products mentioned in the following, please refer to the corresponding Instructions for Use!

### Temporary Cementation

If a composite resin cement is used for permanent cementation:

- For temporary cementation use eugenol-free temporary cement. Residual eugenol-containing products may inhibit the setting of composite resin cements during the permanent cementation process!

If a conventional cement is used for permanent cementation:

- Use a common commercial temporary cement.

### Conventional Cementation

For cementing, use conventional 3M ESPE Ketac™ Cem Glass Ionomer Cement or RelyX™ Luting Cement. The use of phosphate cements are not indicated for use with Lava™ restorations.

### Adhesive Cementation

The strength of Lava Frame frameworks is high. Adhesive cementation does not provide significant mechanical advantages as the Lava material can neither be etched nor directly silanated.

For adhesive bonding, the Lava restorations internal surfaces must be silicated with 3M ESPE Rocatec™ Soft or Cojet™ Sand, and then silanized with ESPE™ SIL Silane or RelyX™ Ceramic Powder. For details on processing, please refer to the Instructions for Use of the Rocatec System or Cojet Sand.

### Use of the Rocatec System in the Laboratory:

- The restoration can be tried in, if desired.
- Then silicate the internal surfaces of the restoration with Rocatec Soft.
- Apply ESPE SIL or RelyX Ceramic Powder coupling agent and allow to dry.
- Soon thereafter, place in the mouth with RelyX™ ARC Adhesive Resin Cement. Please follow Instructions for Use.

### Use of Cojet Sand in the Dental Office:

- First, try in and then silicate the surfaces with Cojet Sand.
- Apply ESPE-Sil or RelyX Ceramic Powder primer and allow to dry.
- Soon thereafter, place in the mouth with composite attachment cement RelyX ARC adhesive resin cement.
- Follow the corresponding Instructions for Use.

### Removal of a Seated Lava Restoration

To remove a seated restoration, use appropriate, water cooled rotary instruments to slit restoration though ceramic. Use appropriate instrumentation to remove restoration from tooth structure.

### Troubleshooting Common Problems

| Error | Cause | Solution |
|---|---|---|
| Framework shows spots after coloring. | Coloring liquid did not dry evenly. | All excess coloring liquid must be removed very carfully by blotting with tissue. |
| Coping breaks during removal from the Lava Frame blank (after Milling). | Holding pin was separated from milled framework too far away from framework surface. | Separate closer to milled framework to reduce vibrations. |
| | Bur “wobbles“ in | Check the handpiece turbine. |
| handpiece chuck. | | |
| | Bur is dull. | Use a new bur. |
| Framework does not fit working model. | Movement (shrinkage) during sintering is restricted by abutments binding on sintering stands. | Ensure proper positioning during sintering as described under “Positioning for Sintering”. |
| | Die was not oriented to the correct position on the model during scanning. | Prior to scanning, check the proper positioning/ orientation of the die on working model. |
| Contamination is apparent on the coping surface | Coloring liquid is contaminated due to repeated use. | Use coloring liquid only once! |
| Whitish spots are apparent on the coping surface | Milling dust was not removed from coping prior to coloring and sintering. | Carefully remove all milling dust prior to coloring. |

### Storage and Shelf Life

Do not store the Lava™ Frame shade coloring liquid above 25°C/77°F. Avoid direct exposure to sunlight.

Do not use after the expiration date.

### Packaging

12 Crown blanks

12 Bridge blanks, 3-unit

300 ml Lava Frame shade coloring liquid each of the following colors:
FS1, FS2, FS3, FS4, FS5, FS6, FS7

1 Sintering tray

1 Sintering box

*Date of the Information 08/01*

## The Veneer Ceramic

### Lava™ Ceram
### Veneer ceramic for Lava Frame zirconium oxide frameworks

### Product Description

Lava Ceram veneer ceramic and the Lava Frame work ceramic are components of the Lava system, for the fabrication of all-ceramic restorations. Frame and veneer ceramic have been specially developed to complement each other and cannot be combined with other ceramic materials.

Lava Ceram ceramic is available in 16 Vita™ shades. The color range comprises the following components: 7 shoulder materials, 16 framework modifiers, 16 dentine materials, 10 Magic intensive materials, 4 incisal materials, 2 enamel effect materials, 4 Transpa-Opal materials, 1 Transpa-Clear material, 10 extrinsic colors, 1 glaze and the accompanying mixing liquids.

Please retain these instructions for future reference.

### Preparation of Lava Frameworks prior to veneering with Lava System

***Framework preparation***

- Clean the colored and sintered framework in an ultrasonic bath.
  The framework must be absolutely clean and contaminant free!

***Shade Selection***

*Combination table in accordance with Vita-Classic shades*

| VITA-Classic Shades | A1 | A2 | A3 | A3.5 | A4 | B1 | B2 | B3 | B4 | C1 | C2 | C3 | C4 | D2 | D3 | D4 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 7 shoulder materials | SH 1 | SH 3 | SH 3 | SH 4 | SH 4 | SH 1 | SH 2 | SH 5 | SH 5 | SH 2 | SH 6 | SH 6 | SH 6 | SH 7 | SH 7 | SH 7 |
| 16 framework modifiers | MO A1 | MO A2 | MO A3 | MO A3.5 | MO A4 | MO B1 | MO B2 | MO B3 | MO B4 | MO C1 | MO C2 | MO C3 | MO C4 | MO D2 | MO D3 | MO D4 |
| 16 dentine materials | D A1 | D A2 | D A3 | D A3.5 | D A4 | D B1 | D B2 | D B3 | D B4 | D C1 | D C2 | D C3 | D C4 | D D2 | D D3 | D D4 |
| 4 incisal materials | E 2 | E 2 | E 3 | E 3 | E 4 | E 1 | E 1 | E 3 | E 3 | E 4 | E 3 | E 3 | E 4 | E 4 | E 3 | E 3 |

*Shade table*

| | | |
|---|---|---|
| Shoulder materials:<br>SH 1 – SH 7 | Framework modifiers:<br>MO A1 – MO D4 | Dentine materials:<br>D A1 – D D4 |
| Incisal materials:<br>E 1 – E 4 | Enamel effect materials:<br>E 5 Polar<br>E 6 Sun | Transparent-Opal materials:<br>T 1 neutral<br>T 2 yellow<br>T 3 blue<br>T 4 grey |
| Magic<br>Intensive materials:<br>I 1 Ocean blue<br>I 2 Atlantis<br>I 3 Chestnut<br>I 4 Havanna<br>I 5 Orange<br>I 6 Khaki<br>I 7 Vanilla<br>I 8 Honey<br>I 9 Gingiva<br>I 10 Violet | Extrinsic colors:<br>S 1 Ocean blue<br>S 2 Atlantis<br>S 3 Chestnut<br>S 4 Havanna<br>S 5 Orange<br>S 6 Khaki<br>S 7 Vanilla<br>S 8 Honey<br>S 9 Gingiva<br>S 10 Violet | Glaze material:<br>G<br><br>Transpa- Clear:<br>CL |

- Prepare the required materials in accordance with the tooth shade.

## Building a crown

### *Mixing*

The following mixing liquids are available:

- Modelling liquid
- Shoulder material liquid
- Extrinsic colors liquid
- Mix the materials and the appropriate liquid to a creamy consistency using a glass or agate spatula. The mixing proportions by weight are 2.5 g powder component to 1 g liquid.

### *Layering shoulder materials*

*If the framework is designed for shoulder material firing or the margin has been inadvertently damaged, shoulder material firing is required.*

- Use shoulder material appropriate to the tooth shade and mix with shoulder material liquid.
- Isolate the model (die) with commercially available seperator.
- Place the framework on the model (die).
- Model the shoulder material on the die as necessary
- Remove the framework from the model and fire the finished shoulder as described under “Firing.”

- Compensate for the sintering shrinkage by a second shoulder material firing, if necessary.

***Application of framework modifier***

*The framework modifier gives the bridge framework its basic color.*

- Mix the framework modifier with modeling liquid.
- Apply a thin coat (0.1 – 0.2 mm) to the entire surface of the framework to be venerred.
- To achieve satisfactory wetting, vibrate gently and blot to avoid bubble entrapment
- If desired, apply magic intensive shades to the framework with a damp brush, or mix with framework modifier as necessary.
- Fire the framework modifier separately (procedure as for “First firing”) or apply the dentine layer directly to the unfired framework modifier.

***Dentine/incisal layering***

- Mix dentine, incisal materials and transparent materials with modelling liquid and build as required.
- Dentin, incisal, and Transpa shades are also layered and/or mixed as necessary.
  - Because of their intensity only use magic shades in small quantities.
- Before the first firing separate bridge units interdentally, to the framework.
- Carry out the first firing in accordance with the firing table, see “Firing”.
  - The ceramic does not have to be roughened or sandblasted afterwards.
- If necessary, correct the shape with fine-grained diamond bur at low RPM.
  - Under no circumstances must the framework be sectioned interdentally!
- Complete the restoration with additional firings as necessary to achieve final form.
- Carry out the corrective firing in accordance with the firing table, see “Firing.”

***Finishing***

*NOTE: Dust from grinding may cause eye and respiratory system irritation. Wear protective goggles. Use with appropriate local exhaust ventilation; in situations where local exhaust ventilation is not adequate, wear appropriate respiratory protection.*

- Finish with fine-grain diamond bur at low RPM.
- Use diamond discs to separate the veneer ceramic only, not the framework!
  - Under no circumstances must the framework be damaged interdentally, otherwise a fracture of the restoration may result!
- Characterize the surface with rotary instruments as required.

- Apply shade characterizations with a mixture of extrinsic colors (stains) and glaze material. Glaze may also be applied separately in a thin layer.
- The final glaze firing is completed in accordance with the firing table, see “Firing.”

***Firing***

| | Start temp. | Drying time | t ↗ under vacuum | t ↗ without vacuum | Final temp. | Hold time under vacuum | Hold time without vacuum |
|---|---|---|---|---|---|---|---|
| 1.+ 2. Shoulder material firing | 450°C | 4 mins | 45°C/min | - | 830°C | 1 min | - |
| First dentine and incisal firing | 450°C | 6 mins | 45°C/min | - | 810°C | 1 min | - |
| Second dentine and incisal firing (corrective firing) | 450°C | 6 mins | 45°C/min | - | 800°C | 1 min | - |
| Glaze firing with glaze material or extrinsic color | 480°C | 2 mins | - | 45°C/min | 790°C | - | 1 min |
| Glaze firing without glaze material or extrinsic color | 480°C | 2 mins | - | 45°C/min | 820°C | - | 1 min |

These temperatures should be used as a guide.  Make adjustments as necessary to accommodate variations in furnaces.

## Intraoral repair of a veneer

*Veneers of fixed restorations may be repaired using the Cojet™ System and a restorative composite.*

- For information on use please refer to the Cojet System instructions for use.

## Avoiding errors during use

***Voids in the veneer layer***

*Voids may occur due to the generally known causes, but are also produced by improperly applied framework modifier. In such cases the framework modifier has not wetted the framework adequately and “lift-off” of the modifier layer may result.*

- To achieve satisfactory wetting,vibrate gently and blot as necessary.

## Storage and shelf-life

Do not store the liquids at temperatures exceeding 25°C/77°F.
Do not use after the expiration date on the package.

## Types of packs

***Master Set***

7 Shoulder materials, 15 g, SH 1 – SH 7
16 Framework modifiers, 15 g, MO A1 – MO D4
16 Dentine materials, 15 g, D A1 – D D4
4 Incisal materials, 15 g, E 1 – E 4
2 Enamel effect materials, 15 g, E 5 + E 6
4 Transparent-Opal materials, 15 g, T 1 – T 4
10 magic Intensive materials, 5 g, I 1 – I 10
10 Extrinsic colors, 5 g, S 1 – S 10
1 Glaze material, 15 g, G
1 Transpa-Clear material, 15 g, CL

***Single packs***

50 g powder component per shade:
Shoulder materials, SH 1 – SH 7,
Framework modifiers, MO A1 – MO D4
Dentine materials, D A1 – D D4
Incisal materials, E 1 – E 4
Enamel effect materials, E 5 or E 6
Transparent-Opal materials, T 1 – T 4
Transpa-Clear material, CL
Glaze material, G

5 g powder material per shade:
Extrinsic colors, S 1 – S 10
Magic Intensive materials, I 1 – I 10

*Date of issue 03/01*

# Questions and Answers

***How comprehensive is the clinical experience with the 3M ESPE Lava™ System?***
The first fixed prosthetics utilizing Lava zirconia were cemented at the end of 1999. By August 2001 there were more than 600 cases in situ, about 100 of them posterior bridges. But it must be remembered that this is the first time that an all-ceramic system of such high strength has been available. Laboratory simulation experiments verify a unprecedented long-term strength. There is now every indication that Lava restoratives may be used for metal-free prosthetics in both posterior and anterior regions!

***What distinguishes the Lava System from the other all-ceramic systems and what is its composition?***
Lava system is based on a framework made from zirconia (Lava Frame) and a feldspathic veneer ceramic (Lava Ceram), which has been specially designed to meet the requirements of the framework with a low coefficient of thermal expansion. The zirconium oxide ceramic is a tetragonal polycrystalline zirconium oxide partially stabilised with yttria (admixture of approx. 3 mol-%) (Y-TZP = Yttria Tetragonal Zirconia Polycrystals).

***How does the accuracy of fit compare with typical porcelain fused to metal?***
Literature indicates a theoretically required accuracy of 50 - 100 µm for crowns & bridges. Internal and external investigations verify an accuracy of fit with crowns and bridges designed and fabricated using the Lava system.

***Is the Lava material really sufficiently strong for posterior bridges? How does the strength compare with other all-ceramic materials and what bridge lengths are possible?***
With zirconium oxide frameworks, strengths that exceed the maximum masticatory load (450N) several times over are possible for the first time even in posterior applications. Internal and external investigations confirm 3-unit bridges after artificial aging (simulation of 5 years of wear) in the mastication simulator (1.2 million cycles) with simultaneous thermocycling (100,000 × 5°-55°C) a strength of 1,200 N to 1,400 N for 4- or 3-unit bridges. So far only 3-unit bridges have been recommended as an indication, primarily due to current software limitations. Software upgrades will enable longer span bridgework to be milled in the near future.

***How aesthetic are the results with Lava restorations? Is zirconium oxide white (-opaque)?***
All independent examiners confirm the excellent esthetics provided by the Lava system. The Lava zirconia framework is ideally translucent due to its high density (no residual porosity) and homogeneity - no longer white-(opaque), as we know it from the past technical/medical applications. Interestingly, the framework wall thickness of 0.5 mm, which is possible due to the high strength of zirconia provides ample opportunity for esthetic layering with the veneer ceramic. There is the unique option of coloring the zirconia framework in 7 Vita™-Classic shades. The veneer system provides a range of intensive and characterizing materials, in addition to 16 Vita-Classic shades.

***What are the preparation requirements for a successful long-term restoration?***
In principle, many of the requirements for a porcelain fused to metal restoration can be applied to the Lava™ system. Fabrication of a Lava restoration requires a preparation having a circumferential chamfer or shoulder. The preparation angle should be 4° or greater. This requirement is dictated by the scanner utilizing white light: it is not possible to scan the surface of the die accurately at an angle below 4°. The inside angle of the shoulder preparation must have a rounded contour. The preparation for the Lava all-ceramic restoration can be done with removal of less tooth structure thanks to the framework's thin wall thickness of only 0.5 mm. Supragingival preparations are possible due to the Lava System's excellent fit characteristics and optical properties.

***Why don't Lava restorations have to be luted using adhesive? Which cement is recommended?***
Conventional cementation with 3M ESPE Ketac™ Cem, or RelyX™ Luting Cement is recommended for the insertion of crowns and bridges made from Lava all-ceramic for every indication. This method has proven reliable. Another advantage is the easy removal of excess cement. Adhesive bonding is possible, e.g. after silicatisation with 3M ESPE Rocatec™ Bonding System or Cojet™ Bonding System, and RelyX™ ARC Adhesive Resin Cement.

Glass ceramics are frequently luted with adhesive bonding, to enhance esthetics and increase the integrity of the entire tooth/restoration system. This no longer applies with polycrystalline oxidic ceramics (Lava Ceram). This method of cementation cannot produce any further increase in strength in this case. There are no esthetic disadvantages in using glass ionomer-based cements (e.g. Ketac Cem Luting Cement) with the Lava system.

# Summary

With the Lava™ System 3M ESPE presents the new, innovative CAD/CAM technology for all-ceramic crowns and bridges on a zirconium oxide base.

Due to the remarkable strength and stability of zirconia, Lava restorations are now indicated for posterior crowns and bridges. Excellent fit is achieved by a coordinated system.

Preparation can be achieved with removal of less tooth structure, and cementation can be carried out according to proven conventional techniques.

The esthetic capability and biocompatibility of Lava restorations represent the optimum in all-ceramic systems. Colorable frameworks of ideal translucency and thin coating thickness to which color can be applied ensure a natural appearance due to the wide scope for characterisation.

The correct finishing of zirconia frameworks in the green state prevents damage to the microstructure of the material, and ensures an excellent long-term prognosis for Lava restorations.

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# Technical Data

*(internal and external sources)*

### 3M ESPE Lava™ Frame Framework Ceramic

| | |
|---|---|
| MOR 4-point bending test (ISO 6872) | 1272 MPa |
| MOR 3-point bending test (ISO 6872) | 1625 MPa |
| Weibull strength ($\sigma 0$) | 1345 MPa |
| Stress resistance (2% / 5 years) | 615 MPa |
| (Youngs) Modulus of elasticity (E) | 210 GPa |
| Weibull modulus (m) | 10.5 |
| Crack growth parameter (n) | 50 |
| Fracture toughness ($K_{IC}$) | 10 MPa $m^{1/2}$ |
| CTE | 10 x $10^{-6}$ 25-500°C |
| Vickers hardness (HV 10) | 1250 |
| Melting point | 2700 °C |
| Grain size | 0.5 µm |
| Density ($\rho$) | 6.08 $g/cm^3$ |
| Solubility (ISO 6872) | 0 $µg/cm^2$ |

### 3M ESPE Lava™ Ceram Veneer Ceramic

| | |
|---|---|
| Weibull strength ($\sigma B$) | 95 MPa |
| MOR 4-point bending test (ISO 6872) | 85 MPa |
| (Youngs) Modulus of elasticity (E) | 80 GPa |
| Fracture toughness ($K_{IC}$) | 1.2 MPa $m^{1/2}$ |
| CTE | 10 x $10^{-6}$ 25-500°C |
| Vickers hardness (HV 0.2) | 530 |
| Firing temperature | 810°C |
| Grain size ($d_{50}$) | 25 µm |
| Density ($\rho$) | 2.5 $g/cm^3$ |
| Solubility (ISO 6872) | 0 $µg/cm^2$ |

### 3M ESPE Lava™ clinically relevant real geometry

***Fracture strength 3-unit Posterior bridge***

| | |
|---|---|
| a) initial | approx. 1800 N |
| b) after mastication simulation and thermocycle | approx. 1450 N |

***Fracture strength 3-unit Anterior bridge***

| | |
|---|---|
| a) initial | approx. 1430 N |
| b) long-term strength at 250 N (above masticatory force) | no fracture |

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