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3M℠ Health Care Academy

A Collection of Scientific Facts

3M™ Lava™ Esthetic Fluorescent Full-Contour Zirconia

2017/2018

Welcome

Each year the International Association for Dental Research (IADR) holds numerous conferences for the communication of scientific and technological advancements in oral care.

Through our 3M℠ Health Care Academy brand, we are pleased to share with you this collection of “Scientific Facts” summarizing research on 3M™ Lava™ Esthetic Fluorescent Full-Contour Zirconia presented at these meetings. The extensive characterization of this unique material, prior to and after commercialization, covers a wide array of topics from natural tooth like fluorescence, quantifying ease of adjustment, determination of the adhesive durability to resin cements to numerous measurements of the mechanical and chemical durability.

3M Oral Care is in the unique position to leverage more than 46 diverse corporate technology platforms and has more than 5,000 corporate research and development staff to transform research into innovative products and solutions that benefit dental professionals and their patients.

Whether or not you were able to attend any of these conferences, we hope you continue to engage our research team as we all work to make better dentistry possible.

Sincerely,
3M Oral Care
Lifelong Oral Health for Everyone

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J Dent Res Vol #96 (Spec Iss A): 0094, 2017

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Grinding Behavior of a Novel Esthetic Full-Contour Zirconia

Authors:

Rainer Dittmann **(Presenter)**, 3M Oral Care
Michaela Urban, 3M Oral Care
Björn Theelke, 3M Oral Care
Philipp Doebert, 3M Oral Care
PJ Flanigan, 3M Oral Care

Abstract:

Objectives: In this study the grinding behavior of sintered CAD/CAM zirconia restoration materials was investigated in a standardized *in vitro* test setup that simulates clinical procedures. The result gives an indication about the ease of adjustment and removal of restorations made from the different materials.

Methods: Sample bars (n=5) were cut from 3M™ Lava™ Plus High Translucency Zirconia (LPZ) and a novel material 3M™ Lava™ Esthetic Fluorescent Full-Contour Zirconia (LEZ). Samples of both materials were sintered according to instructions to final dimensions of l=17mm w=1.25mm h=6mm. Each sample was placed in a longitudinal moving abrasion test device (Elcometer 1720) allowing a free mobility in z-direction to apply a constant load of 2.6 N. The sample side (l*w) was moved back and forth (path length l=9.8mm, frequency f=120 cycles/min for a time t=30 s) over an orthogonally fixed dental turbine handpiece (KaVo INTRAsurg 300 with W&H WS-92 E/3 handpiece) with a red ring diamond cylinder (edenta diamond instruments FG K881.016) running constantly at 108,000 rpm with water cooling. The grinding profile and sample width were measured with a laser scanning microscope (Keyence VK-X200) and the amount of removed zirconia material was calculated.

Results: The removed zirconia volumes (dV) are summarized in Table 1. 2-sample-t-test ($p<0.05$) was performed for LPZ and LEZ. dV is significantly higher for LEZ compared to LPZ.

Conclusions: In this standardized grinding experiment it has been shown that higher volumes are removed from LEZ compared to LPZ with a diamond tool at similar time and load. The result reveals that LEZ is easier to grind compared to LPZ in clinical situations. This suggests an advantage if contact points of restorations have to be adjusted or when restorations have to be removed.

Grinding Behavior of a Novel Esthetic Full-Contour Zirconia (cont.)

Table 1

Sample	3M™ Lava™ Plus High Translucency Zirconia dV (mm^3)	3M™ Lava™ Esthetic Fluorescent Full-Contour Zirconia dV (mm^3)
1	7.3	13.3
2	6.9	11.5
3	7.2	11.6
4	7.3	11.8
5	8.2	11.4
Mean	7.4	11.9
Standard Deviation	0.5	0.8

3M Oral Care Summary:

Study Objectives: To determine the ease of adjustment and/or removal of 3M™ Lava™ Esthetic Fluorescent Full-Contour Zirconia restorations.

Summary of Results: Lava Esthetic zirconia will take less time to adjust, perforate for endodontic access or crown removal based on the volume of material ground away with a red ring diamond for a given period of time compared to 3M™ Lava™ Plus High Translucency Zirconia.

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J Dent Res Vol #96 (Spec Iss A): 0096, 2017

3M℠ Health Care Academy

Roughness, Gloss and Opposing Enamel Wear of Translucent Zirconia

Authors:

Sung Joon Kwon **(Presenter)**, University of Alabama Birmingham
Preston Beck, University of Alabama at Birmingham
John Burgess, University of Alabama at Birmingham
Nathaniel Lawson, University of Alabama at Birmingham

Abstract:

Objectives: To compare wear, antagonistic enamel wear, gloss and roughness of as-sintered, polished and glazed 3M™ Lava™ Esthetic Fluorescent Full-Contour Zirconia.

Methods: Pre-sintered zirconia blanks were cut using a dry saw and hand-sanded with P2500 sand paper. Samples were sintered by heating for 10°C/min to 1500°C and holding at temperature for 2 hours. Three sets of specimens (n=8) were prepared as follows: 1) "As-sintered", 2) glazed with IPS e.max® Ceram following the manufacturer's IFU and 3) hand polished with NTI® CeraGlaze® Polishers (coarse, fine, and super fine) at 10,000 RPM followed by an Intra-oral DiaShine Fine paste using a soft bristle brush. Wear against maxillary central incisor enamel was measured as a reference. Specimens were mounted in the Alabama Wear Machine against modified human premolar antagonists and tested for 300,000 cycles (20N, 2mm sliding distance, 1Hz frequency, and 33% glycerin lubrication). Volumetric loss of zirconia and opposing enamel was measured using non-contact light profilometrey (10µm resolution). Surface roughness (R_a) was measured with a non-contact, light profilometer. A 4mm length was measured with 0.8mm cutoff length, and 136 surface filter number. Gloss was measured with a glossmeter (Novo-Curve). Data for each property was analyzed using individual 1-way ANOVAs and Tukey post-hoc analyses (alpha=0.05).

Conclusions: Polished and as-sintered Lava Esthetic zirconia had no detectable wear while glazed specimens only showed wear of the glaze. Polished Lava Esthetic zirconia created the least amount of opposing enamel wear. Enamel, glazed and as-sintered specimens were in the same range. Polishing or glazing Lava Esthetic zirconia improved its gloss and decreased its roughness. Project sponsored by 3M.

Roughness, Gloss and Opposing Enamel Wear of Translucent Zirconia (cont.)

Sample	Roughness (R_a)	Gloss (GU)	Volumetric Wear (mm^3)	Enamel Wear (mm^3)
As-is	0.158A	28.1A	0	0.230A±0.094
Glazed	0.055B	76.3B	0.058±0.014	0.306A±0.128
Polished	0.027C	180.9C	0	0.068B±0.021
Enamel	—	—	0.142±0.146	0.280A±0.213

3M Oral Care Summary:

Study Objectives: To determine the abrasivity of 3M™ Lava™ Esthetic Fluorescent Full-Contour Zirconia against a natural enamel antagonist.

Summary of Results: These results indicate that Lava Esthetic zirconia is wear friendly to opposing enamel.

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J Dent Res Vol #96 (Spec Iss A): 0097, 2017

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Flexural Strength of a Novel Esthetic Full-Contour Zirconia Compared to Other Ceramics

Authors:

Björn Theelke, 3M Oral Care
PJ Flanigan **(Presenter)**, 3M Oral Care
Michael Jahns, 3M Oral Care
Rainer Dittmann, 3M Oral Care

Abstract:

Objectives: In this study the flexural strength of various ceramic restoration materials including a novel zirconia product was investigated. Different surface preparations which appear on final restorations have been tested for each material.

Methods: Bending bars were cut from CAD/CAM mill blanks, chamfered and sintered or crystallized and prepared to final dimensions (16 x 4 x 1.2mm). The investigated materials were 3M™ Lava™ Plus High Translucency Zirconia (LP), 3M™ Lava™ Esthetic Fluorescent Full-Contour Zirconia (LE) and Ivoclar IPS e.max CAD (EM). Each material sample set was divided in three groups (n=30). One group of each material was tested "as fired" without further treatment and one was polished acc. ISO6872:2015. A third group was treated according to cementation recommendations by sand blasting (2bar, 50μm Corundum) for zirconia or an etching step (IPS Ceramic Etching Gel) for glass ceramic. The bending bars were loaded until fracture in a 3-point-bending setup.

Results: Mean flexural strength (FS) acc. ISO6872:2015 results are summarized in Table 1 and visualized in Diagram 1. 2-sample-t-tests ($p<0.05$) have been performed for all groups. Groups with significant difference are marked with the different letters in Table 1. Mean FS of the three investigated materials differs significantly from each other independent from surface preparation in the following order LP > LE > EM. Compared to polished groups the samples with surface preparation required for cementation resulted in significant lower FS for LE and EM materials and showed no significant difference for LP.

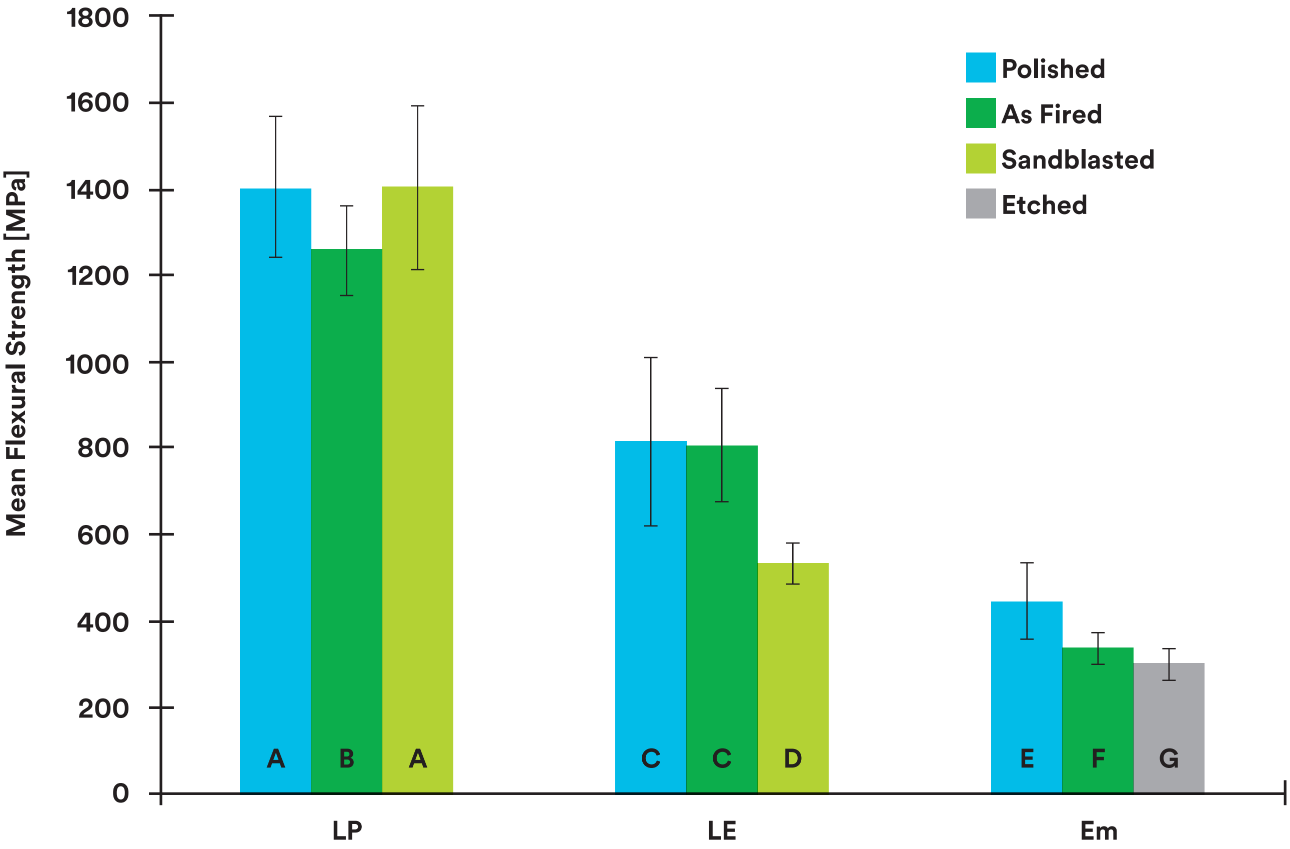
Conclusions: The significant different FS values of the three tested materials need to be considered for restoration design and indication range. LP allows widest indication range. The novel zirconia LE exceeds with all tested surface preparations the recommended ISO6872:2015 limits for Type II, Class 4 indications which supports the use of this material for 3-unit bridges in anterior and posterior situations. EM is limited to 3-unit bridges anterior. This is also reflected in the minimum occlusal wall thickness (for posterior LP 0.5mm, LE 0.8mm, EM 1.5mm).

Flexural Strength of a Novel Esthetic Full-Contour Zirconia Compared to Other Ceramics (cont.)

Table 1

Material		3M™ Lava™ Plus High Translucency Zirconia			3M™ Lava™ Esthetic Fluorescent Full-Contour Zirconia			IPS e.max® CAD		
Surface		Polished	As Fired	Sandblasted	Polished	As Fired	Sandblasted	Polished	As Fired	Sandblasted
Flexural Strength (MPa)	Mean	1404	1258	1403	814	807	533	446	337	300
	Standard Deviation	162	104	191	195	130	47	90	37	36
Statistical Group		A	B	A	C	C	D	E	F	G

Diagram 1



3M Oral Care Summary:

Study Objectives: To determine the flexural strength of zirconia and glass-ceramic restoration materials after being subjected to their surface treatment protocol recommended for cementation.

Summary of Results: 3M™ Lava™ Esthetic Fluorescent Full-Contour Zirconia's flexural strength continues to exceed the minimum requirements for an ISO 6872:2015 Type II, Class 4 ceramic material even after being abraded with 50µm alumina.

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J Dent Res Vol #96 (Spec Iss A): 0098, 2017

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Inherently Fluorescent Esthetic Full-Contour Zirconia

Authors:

Michael Jahns **(Presenter)**, 3M Oral Care
Rainer Dittmann, 3M Oral Care
Julia Farr, 3M Oral Care
Grit Kindler, 3M Oral Care
PJ Flanigan, 3M Oral Care

Abstract:

Objectives: Recently, monolithic zirconia has made big steps toward becoming a highly esthetic restorative material by significant improvements in translucency. One other important feature is inherent fluorescence that matches that of natural dentin. While fluorescence for zirconia is already available for some materials in light tooth shades, it will be shown that this feature now has become available for all tooth shades.

Methods: Specimens (1mm thickness) were obtained by slicing dental materials (3M™ Lava™ Esthetic Fluorescent Full-Contour Zirconia A1, A3.5 cut from the body section and 3M™ Lava™ Plus High Translucency Zirconia shaded by immersion in 3M™ Lava™ Plus Dyeing Liquids A1, A3.5 in combination with 3M™ Lava™ Plus Effect Shade Fluorescence; from Kuraray Noritake: Katana™ STML A1 cut from the body section; from Ivoclar Vivadent: IPS e.max® CAD LT A1). Zirconia specimens were fired to full density, glass-ceramic specimens were crystallized according to IFU. The color of the obtained samples was measured, irradiating with artificial daylight with and without UV component, using a Color i7 from X-Rite. Fluorescence spectra were obtained by subtraction of spectra measured without UV from spectra measured with UV. As fluorescent reference material, bovine dentin was used.

Results: The Lava Esthetic zirconia samples show a broad fluorescence spectrum with a maximum at about 450nm (blue) that is very similar to the spectrum of bovine dentin. The glass-ceramic sample shows fluorescence with a peak at 550nm (green/yellow) (Fig. 1). The fluorescence intensity decreases with darker shades. Lava Esthetic zirconia constantly shows a higher fluorescence than Lava Plus zirconia (Fig. 2).

Conclusions: Lava Esthetic zirconia shows strong, dentin-like fluorescence even in combination with dark shades like A3.5. Lava Plus zirconia is noticeably fluorescent only when light shades like A1 are applied. The Katana sample is not fluorescent. IPS e.max CAD shows fluorescence, but the fluorescence color deviates from that of natural dentin.

J Dent Res Vol #96 (Spec Iss A): 0098, 2017

Inherently Fluorescent Esthetic Full-Contour Zirconia (cont.)

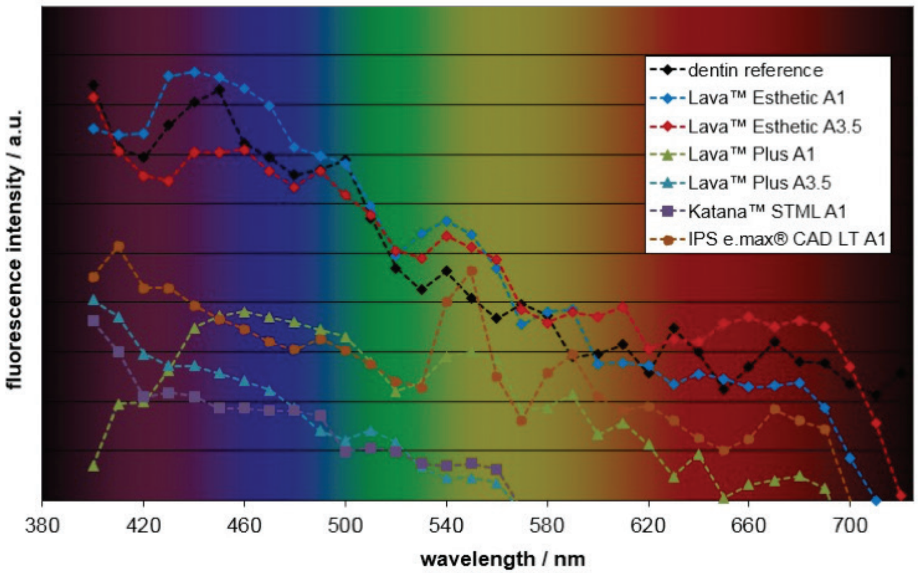

Figure 1. Fluorescence spectra.

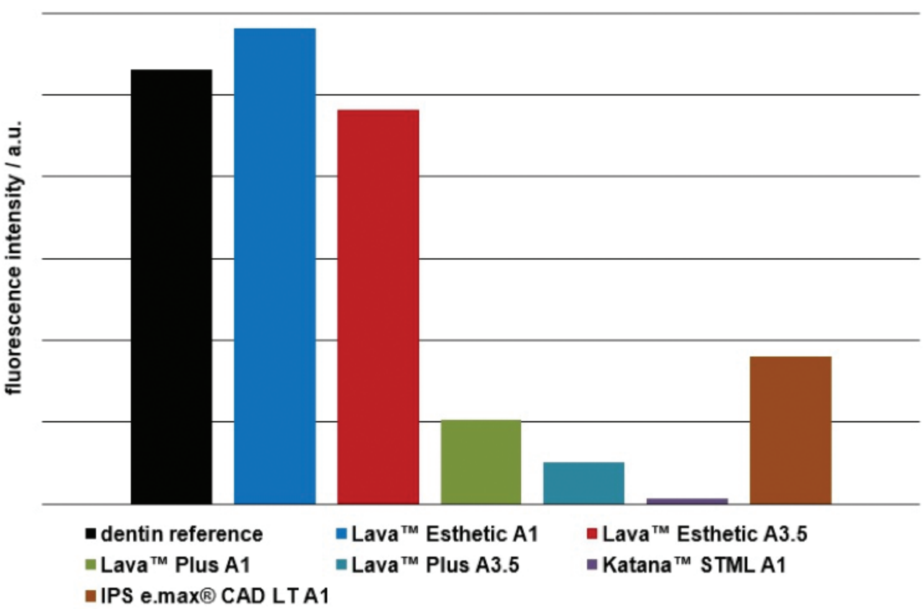

Figure 2. Fluorescence intensities obtained by integration over fluorescence spectra from 400 to 500nm.

3M Oral Care Summary:

Study Objectives: To measure the fluorescence of 3M™ Lava™ Esthetic Fluorescent Full-Contour Zirconia.

Summary of Results: Lava Esthetic zirconia was measured to have a fluorescent intensity similar to a dentin reference in both a light, A1, and dark, A3.5 shade.

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Fracture Strength of Zirconia Crowns With and Without Alumina Abrasion

Authors:

Nathaniel Lawson, University of Alabama at Birmingham
John Burgess **(Presenter)**, University of Alabama at Birmingham
Geoffrey Morris, 3M Oral Care

Abstract:

Objectives: ISO 6872:2015 Class 4 zirconia dental ceramics, which contain significant cubic crystal phase to increase translucency, show a reduction in flexural strength when sandblasted. This study measures the fracture strength of zirconia crowns bonded with 3M™ RelyX™ Unicem 2 Self-Adhesive Resin Cement with and without sandblasting.

Methods: Standardized crown preparations were designed with AutoCAD® software with a 0.8mm shoulder margin and 1mm incisal-cervical marginal curvature. Crowns were digitally designed using 3shape software and milled of 3M™ Lava™ Plus High Translucency Zirconia (n=24) or a translucent zirconia, 3M™ Lava™ Esthetic Fluorescent Full-Contour Zirconia (n=24) and sintered following manufacturers' instructions. Axial and occlusal thickness was 1mm except 0.8mm at the central pit. Dies were milled from fiberglass reinforced polymer with a modulus similar to dentin (18.8GPa). One-half the crowns (not abraded) were bonded. The remaining 1/2 were particle-abraded with 280 mesh alumina (45psi, 10 seconds, 10mm distance). All crowns were bonded with a self-adhesive cement (RelyX Unicem 2 cement) and self-cured for 6 minutes under 200g of applied load. Cemented crowns were load cycled for 100,000 cycles using 100N force in a custom fatiguing device in water at 24°C with a stainless steel ball contacting all four crown cusps. After load cycling, a 1.5mm rubber sheet was placed between the indenter and the crown to simulate a food bolus and the crowns were loaded with a stainless steel indenter (7mm radius) with a crosshead speed of 1mm/min until failure in a universal testing machine. Data was analyzed with ANOVA and t-Test.

Fracture Strength of Zirconia Crowns With and Without Alumina Abrasion (cont.)

Results:

Force to Fracture Crown (N)				
n=8	**3M™ Lava™ Esthetic Fluorescent Full-Contour Zirconia**	**3M™ Lava™ Esthetic Fluorescent Full-Contour Zirconia**	**3M™ Lava™ Plus High Translucency Zirconia**	**3M™ Lava™ Plus High Translucency Zirconia**
Intaglio Surface	As Made	Abraded	As Made	Abraded
Average	4584	5174	8210	8921
Standard Deviation	265	771	919	1086

Conclusions: 280 mesh alumina particle abrasion did not reduce the fracture strength ($p>.05$) of bonded zirconia crowns in this limited *in vitro* study.

3M Oral Care Summary:

Study Objectives: To determine the force required to fracture a 3M™ Lava™ Esthetic Fluorescent Full-Contour Zirconia crown cemented with 3M™ RelyX™ Unicem 2 Self-Adhesive Resin Cement, with and with out the internal surface of the crown sandblasted with aluminum oxide, after fatigue testing.

Summary of Results: No difference was observed in the force required to fracture a Lava Esthetic zirconia crown when the internal surface was sandblasted. The force required to fracture the Lava Esthetic zirconia crowns was > 4X the maximum force the human jaw can exert.

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Surface Treatment on Shear Bond Strength of High Translucent Zirconia

Authors:

Martin Rosentritt **(Presenter)**, UKR University Hospital Regensburg
Michael Behr, UKR University Hospital Regensburg
Carola Kolbeck, UKR University Hospital Regensburg
Verena Preis, UKR University Hospital Regensburg

Abstract:

Objectives: The aim of this investigation was to evaluate bonding opportunities to high translucent zirconia after different surface treatments.

Methods: Shear bond strength was determined between high translucent zirconia plates (3M™ Lava™ Esthetic Fluorescent Full-Contour Zirconia, 3M Oral Care, USA; 2mm, 20mm, 10mm) and CoCr cylinders (d=5mm, height 3mm). Bonding was performed after different activation and cleaning procedures of the plates. Standard zirconia (3M™ Lava™ Plus High Translucency Zirconia) served as a reference. Zirconia in all cases was sandblasted (40µm aluminum oxide, 2bar). Cements: 3M™ RelyX™ Unicem 2 Self-Adhesive Resin Cement, 3M™ RelyX™ Ultimate Adhesive Resin Cement and Multilink® Automix (Ivoclar-Vivadent; FL). Bondings: 3M™ Scotchbond™ Universal Adhesive, Monobond + (Ivoclar). Cleaning was performed with alcohol, NaOCl or water. Individual surfaces were contaminated with human saliva. After 24hrs, TC (12000x 5°C/55°C) and 90d storage (37°C) shear bond strength (SBS) was determined (ISO TR 11405; v=1mm/min, n=10). Bonding areas were classified into adhesive, mixed and cohesive failure. Statistics: mean and standard deviation; one-way ANOVA / Bonferroni (α=0.05).

Results: Shear bond strength after 24hrs varied between 3.5 MPa (#4) and 69.4 MPa (#14). After TC values between 0.0 MPa (#4, no bonding) and 70.3 MPa (5) were found. After 90 days storage the lowest SBS values were found for #4 (0.0 MPa) and highest results for #7 (75.7 MPa). Detailed results see table. The statistical comparison revealed significant differences between the systems. Dominate failure pattern was adhesive.

Surface Treatment on Shear Bond Strength of High Translucent Zirconia (cont.)

					Mean			Standard Deviation		
#	Zirconia	Cement	Procedure	Primer	24h	TC	90d	24h	TC	90d
1	3M™ Lava™ Plus High Translucency Zirconia	3M™ RelyX™ Unicem 2 Self-Adhesive Resin Cement	Alcohol	None	47.8	65.3	61.8	6.4	16.5	13.3
2		3M™ RelyX™ Ultimate Adhesive Resin Cement		3M™ Scotchbond™ Universal Adhesive	58.3	67	57.8	7	17.8	16.1
3	3M™ Lava™ Esthetic Fluorescent Full-Contour Zirconia	3M™ RelyX™ Unicem 2 Self-Adhesive Resin Cement	Alcohol	None	51.8	54	67.3	9.4	17.4	16.1
4			Saliva		3.5	0	0	2.1	0	0
5			Saliva/Water		52	70.3	68.3	8.4	10.6	15.9
6			Saliva/ NaOCl/Water		56.4	66.6	67.9	8.1	8.7	14.1
7		3M™ RelyX™ Ultimate Adhesive Resin Cement	Alcohol	3M™ Scotchbond™ Universal Adhesive	67.7	57.6	75.7	7.9	11	6.9
8			Saliva		49.9	62.9	65.4	12.1	14.1	9
9			Saliva/Water		64.7	66.3	55.8	14.7	15.3	19.9
10			Saliva/ NaOCl/Water		62.3	69.6	63	11.7	19.6	9.9
11		Multilink Automix	Alcohol	Monobond	54.7	67.6	55.1	19.1	24	18.7
12			Saliva		13.7	7	10.8	10.1	16	6.6
13			Saliva/Water		66.6	47.6	26.7	13.8	16.7	11
14			Saliva/ NaOCl/Water		69.4	51	22.4	14.1	12.6	10.7

Conclusions: The use of self-etching cement or adhesive bonding together with cleaning and decontamination guaranteed efficient bonding to translucent zirconia 3M™ Lava™ Esthetic Fluorescent Full-Contour Zirconia.

3M Oral Care Summary:

Study Objectives: To measure the bond strength of 3M™ RelyX™ Unicem 2 Self-Adhesive Resin Cement, 3M™ RelyX™ Ultimate Adhesive Resin Cement and Multilink® Automix to saliva contaminated and decontaminated 3M™ Lava™ Esthetic Fluorescent Full-Contour Zirconia.

Summary of Results: Decontamination by wiping with a 5% NaOCl solution followed by a water rinse, or rinsing with water alone, both followed by an air dry, resulted in bond strengths equivalent to those found for uncontaminated Lava Esthetic zirconia for all cements studied. Mean shear bond strengths in excess of 65 MPa were measured after 90 day storage in 37°C water with RelyX Unicem 2 cement.

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J Dent Res Vol #96 (Spec Iss A): 3206, 2017

3M℠ Health Care Academy

Crystal Phase Composition and Hydrothermal Stability of Zirconia Ceramics

Authors:

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Julia Farr, 3M Oral Care
PJ Flanigan, 3M Oral Care
Arno Schmalzi, 3M Oral Care
Björn Theelke, 3M Oral Care
Rainer Dittmann, 3M Oral Care

Abstract:

Objectives: Zirconia ceramics with higher yttria content and improved esthetics have recently been introduced for dental restorations. In this study the crystal phase composition of CAD/CAM zirconia restorative materials with different yttria content were investigated before and after accelerated hydrothermal treatment.

Methods: Plates (14 x 14 x 2mm) were prepared from 3M™ Lava™ Plus High Translucency Zirconia (LP) and 3M™ Lava™ Esthetic Fluorescent Full-Contour Zirconia (LE). The samples were sintered to full density (LP 1450°C/2h, LE 1500°C/2h). X-ray diffraction measurements were performed on four samples using Bragg-Brentano geometry (Bruker D8 Discover). Quantitative crystal phase analysis was done by the Rietveld method (Bruker TOPAS software). The samples were measured initially and after hydrothermal treatment for 5 hours in a steam autoclave at 135°C under 2 bar.

Results: Crystal phase compositions of zirconia materials are presented in Table 1. LE shows a lower tetragonal and a higher cubic crystal phase content compared to LP in initial state. Monoclinic phase content after hydrothermal treatment is higher for LP compared to LE.

Crystal Phase Composition and Hydrothermal Stability of Zirconia Ceramics (cont.)

Table 1. Crystal phase composition analyzed by XRD

Material		Tetragonal [wt.%]	Cubic [wt.%]	Monolithic [wt.%]	Distorted Cubic [wt.%]
3M™ Lava™ Plus High Translucency Zirconia	Initial	82 +/- 0	18 +/- 0	0 +/- 0	0 +/- 0
	After hydrothermal treatment	62 +/- 1	20 +/- 0	14 +/- 0	4 +/- 0
3M™ Lava™ Esthetic Fluorescent Full-Contour Zirconia	Initial	47 +/- 0	53 +/- 0	0 +/- 0	0 +/- 0
	After hydrothermal treatment	46 +/- 1	51 +/- 0	3 +/- 0	0 +/- 0

Conclusions: LP has initially a higher tetragonal phase compared to LE whereas in LE the cubic crystal phase is dominant.

After hydrothermal treatment LE shows lower monoclinic phase compared to LP which reveals an increased hydrothermal stability of LE.

3M Oral Care Solutions Summary:

Study Objectives: To determine the ability of 3M™ Lava™ Esthetic Fluorescent Full-Contour Zirconia to resist chemical attack by water.

Summary of Results: Lava Esthetic zironia did not degrade after exposure to an accelerated hydrothermal stability test where samples were exposed to water at 135°C, under 2 bar pressure, for 5 hours.

J Dent Res Vol #97 (Spec Iss A): 0995, 2018

Cutting Efficiency of Diamond Burs for Dental Zirconia

Authors:

Akshar Patel **(Presenter)**, University of Alabama at Birmingham
Nathaniel Lawson, UAB School of Dentistry

Abstract:

Objectives: To evaluate cutting efficiency of diamond burs used for dental zirconia.

Methods: A zirconia block (3M™ Lava™ Esthetic Fluorescent Full-Contour Zirconia) was sectioned into 5.4mm thick sections with a lapidary saw. Specimens were then sintered according to the manufacturers recommendation resulting in a final thickness of 2.43mm. Diamond burs were used to cut the zirconia blocks. In a custom UAB Bur Testing Device which used a computer controlled cutting turbine (40,000 RPM) with water spray (5.45L/min) and a 0.98N load. Two cuts were made on every zirconia block for 10 minutes each while using the same bur for both cuts. Four different diamond burs were tested (n=6). A digital light microscope with image analysis software was then used to measure the distance each cut made in the zirconia block. Representative zirconia specimens and diamond burs from each group were gold-coated and examined in a SEM (Quanta FEG 650, FEI) using the secondary electron (SE). The edges of the cutting surfaces were examined for edge chipping. Data were analyzed with 2-way ANOVA and Tukey post-hoc analysis for factors bur type and order of cut (i.e. first or second cut).

Results: See Table 1 on next page.

Cutting Efficiency of Diamond Burs for Dental Zirconia (cont.)

Table 1

Group No.	Bur No./Manufacturer	1st Cut/mg	2nd Cut/mg
1	4ZR.314.014/KOMET USA	1.65±0.30c,d	1.05±0.13c,d
2	5856.314.014/KOMET USA	1.18±0.15a,b	0.96±0.15a,b
3	1116.8M/NeoDiamond	1.78±0.37a	1.08±0.25a
4	Z856-018/Zir-Cut	1.12±0.14a,b,c	0.81±0.16c,d

Conclusions: Factors bur type, order of cut and their interaction were all significant (p<.01). There was no significant difference between cuts for the first cut, however, the NeoDiamond and Komet 4ZR burs produced longer cuts for the second cut. All burs showed significantly greater first cut than second cut. SEM imaging reveals that edge chipping can be observed on the cuts used with the Neodiamond, Komet 4ZR, and Komet 5856.

3M Oral Care Summary:

Study Objectives: Determine the cut rate of 3M™ Lava™ Esthetic Fluorescent Full-Contour Zirconia by several commercially available diamond burs.

Summary of Results: Cut rate and total cut were found to vary from brand to brand of diamond burs.

J Dent Res Vol #97 (Spec Iss A): 1295, 2018

Effect of Location on Strength and Translucency of Multi-layered Zirconias

Authors:

Thomas Hill **(Presenter)**, Ivoclar Vivadent, Inc.
Abigal Heleba, Cornell University
George Tysowsky, Ivoclar Vivadent, Inc.

Abstract:

Objectives: To examine how the biaxial flexure strength and the translucency change as a function of height in multilayered dental zirconias.

Methods: Eight cylinders with a 14.0mm diameter (expanded for the shrinkage) from each of four zirconia pucks (20 – 22mm thickness): 3M™ Lava™ Esthetic Fluorescent Full-Contour Zirconia, e.max® ZirCAD MT-Multi, Katana STML and Katana UTML were milled using Wieland milling system. Pre-fired cylinders were cut in a Buehler IsoMet 1000 saw into seven layers of 1.6mm thick specimens to produce 1.2±0.2mm fired specimens. The un-sintered discs were polished using 800 grit SiC. Eight discs from each layer were sintered at the same time according to the manufacturer's schedule.

Specimens were measured using a Hunter Lab UltraScanVIS Spectrophotometer with a standardized white background and black background using glycerin. Yxy values were obtained for each disc specimen. Using the Y value from the black background and the white background, the contrast ratio was calculated by CR= Yblack/Ywhite.

The disc specimens were loaded in a piston-on-three ball testing fixture detailed in ISO 6872. They were loaded at a loading rate of 0.5mm/minute. The strength values were calculated by:

σ = -0.2387 P(X-Y)/b2

where σ is maximum strength (MPa); P is fracture load (N), X and Y are loading constants derived from loading configuration and Poison's ratio and b is thickness of specimen.

Results: The means and standard deviations of the biaxial flexure strengths and contrast ratios were analyzed with ANOVA and Tukey's HSD post-hoc test ($\alpha \leq 0.05$) and are presented for each material in the tables on the next page.

Effect of Location on Strength and Translucency of Multi-layered Zirconias (cont.)

Conclusions: Within the bounds of this study, e.max® ZirCAD MT-Multi, Katana STML and Katana UTML had the lowest strength values and highest translucency (lowest CR) in the incisal region (layers 1-2) while having the highest strength values and lowest translucency (highest CR) in the body region (layers 4-6).

Table(s)

Flexural Strength (MPa)				
Layer	Katana STML	e.max ZirCAD MT Multi	3M™ Lava™ Esthetic Zirconia	Katana UTML
1	720±96	786±69	840±104	684±86
2	763±66	767±74	841±63	687±76
3	809±74	880±157	825±115	725±54
4	827±44	948±73	862±87	721±49
5	780±70	966±53	855±74	745±82
6	800±59	963±60	852±102	714±43
7	743±93	992±86	805±81	724±129

Translucency (CR)				
Layer	Katana STML	e.max ZirCAD MT Multi	3M™ Lava™ Esthetic Zirconia	Katana UTML
1	0.800±0.053	0.791±0.014	0.847±0.030	0.773±0.019
2	0.801±0.037	0.768±0.022	0.845±0.037	0.771±0.012
3	0.805±0.09	0.802±0.016	0.838±0.002	0.804±0.019
4	0.821±0.041	0.810±0.018	0.840±0.01	0.799±0.018
5	0.818±0.013	0.806±0.023	0.826±0.031	0.814±0.010
6	0.819±0.020	0.814±0.016	0.844±0.013	0.817±0.010
7	0.793±0.010	0.800±0.031	0.820±0.009	0.797±0.017

3M Oral Care Summary:

Study Objectives: Compare the flexural strength and translucency at different positions within multi-layered zirconia products including 3M™ Lava™ Esthetic Fluorescent Full-Contour Zirconia, Katana STML, Katana UTML and e.max ZirCAD MT Multi.

Summary of Results: All products tested were found to exceed the flexural strength requirements for a ISO 6872:2015 Type II, Class 4 material.

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3M℠ Health Care Academy

Fracture Load of Zirconia and Lithium Disilicate Crowns

Authors:

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Geoffrey Morris, 3M Oral Care

Abstract:

Objectives: To measure the fracture load of traditional and translucent zirconia and lithium disilicate crowns bonded with 3M™ RelyX™ Unicem 2 Self-Adhesive Resin Cement and 3M™ RelyX™ Luting Plus Resin Modified Glass Ionomer Cement (RMGI) cement with and without sandblasting.

Methods: Standardized crown preparations were designed with AutoCAD® software with a 0.8mm shoulder margin. Copings (n=8/group) were milled of traditional zirconia (3M™ Lava™ Plus High Translucency Zirconia), translucent zirconia (3M™ Lava™ Esthetic Fluorescent Full-Contour Zirconia) or lithium disilicate (e.max CAD, Ivoclar) and sintered/crystallized following manufacturers' instructions. All copings were a uniform 0.8mm thickness. Dies were milled from composite resin (Crystal Ultra). Two-thirds of the crowns were either particle-abraded with <40μm alumina at 45psi (zirconias) or etched with 5% HF for 20 seconds (lithium disilicate). Half of these crowns were cemented with RelyX Luting Plus Cement and half were bonded with RelyX Unicem 2 cement. One-third of the crowns received no surface treatment and were bonded with RelyX Unicem 2 Cement. All cement was self-cured for 6 minutes under 2kg of applied load. Cemented crowns were load cycled for 100,000 cycles using 100N force in a custom fatiguing device in water at 24°C with a stainless steel ball contacting all four crown cusps. After load cycling, a 1.5mm rubber sheet was placed between the indenter and the crown to simulate a food bolus and the crowns were loaded with a stainless steel indenter (7mm radius) with a crosshead speed of 1mm/min until failure in a universal testing machine. Data analyzed with ANOVA and t-Test.

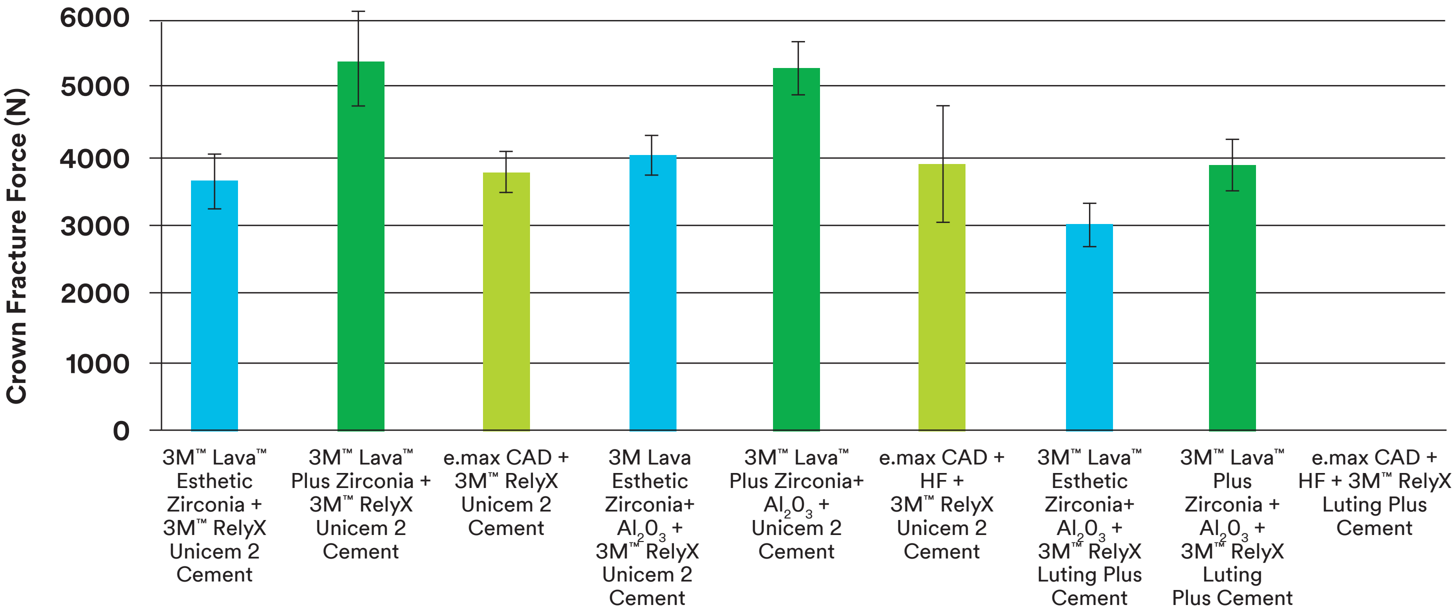
Fracture Load of Zirconia and Lithium Disilicate Crowns (cont.)

Table 1

	3M™ RelyX™ Unicem 2 Self-Adhesive Resin Cement			3M™ RelyX™ Unicem 2 Self-Adhesive Resin Cement Etched/Sandblast			3M™ RelyX™ Luting Plus Resin Modified Glass Ionomer Cement Etched/Sandblast		
	3M™ Lava™ Esthetic Zirconia	3M™ Lava™ Plus Zirconia	e.max CAD	3M™ Lava™ Esthetic Zirconia + Al_2O_3	3M™ Lava™ Plus Zirconia + + Al_2O_3	e.max CAD + HF	3M™ Lava™ Esthetic Zirconia + Al_2O_3	3M™ Lava™ Plus Zirconia + + Al_2O_3	e.max CAD + HF
Fracture Load (N) (mean ± SD)	3647.6 ± 396.3b	5383.5 ± 713.0a	3768.4 ± 286.8b	4007.9 ± 287.2b	5272.2 ± 383.2a	3883.1 ± 847.4b	3007.4 ± 320.8c *(2)	3865.6 ± 363.6b	0 ± 0 *(8)

* Indicates number of pretest fractures

Diagram 1



Conclusions: In this limited in vitro study 50µm alumina particle abrasion did not reduce the fracture strength ($p>.05$) of bonded zirconia crowns, bonded lithium disilicate and translucent zirconia produced equivalent strength, and more translucent zirconia crowns survived fatigue than lithium disilicate when cemented with RMGI cement.

3M Oral Care Summary:

Study Objectives: To understand the impact of crown surface treatment protocols on fatigue resistance of 0.8mm thick copyings of 3M™ Lava™ Plus High Translucency Zirconia, 3M™ Lava™ Esthetic Fluorescent Full-Contour Zirconia and e.max crown RMGI or a self-adhesive resin cement is utilized.

Summary of Results: Sandblasting the inside surface did not statistically change the force required to fracture fatigued Lava Plus zirconia or Lava Esthetic zirconia crowns when cemented using 3M™ RelyX™ Unicem 2 Self-Adhesive Resin Cement.

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3M℠ Health Care Academy

Effect of Shading on Flexural Strength of Cubic Full-Contour Zirconia

Authors:

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Abstract:

Objectives: In this study the flexural strength of a gradient shaded cubic full-contour zirconia ceramic was investigated. Shades from light to dark were tested to evaluate if coloring has an impact on mechanical properties.

Methods: He investigated materials were 3M™ Lava™ Esthetic Fluorescent Full-Contour Zirconia Discs in the shades A1, A3.5, B2, C4 and D3. Bending bars were cut from pre-sintered blanks, chamfered, smoothened with P2500 sandpaper and sintered to final dimensions of 18 x 4 x 1.2mm. Surface of samples for flexural strength testing was "as fired" without further preparation in sintered state. The bending bars were loaded until fracture in a 3-point-bending setup with 12mm load span and 1mm/min load speed.

The flexural strength test has been performed in accordance to ISO6872:2015 recommendations. Mean flexural strength and standard deviation was calculated. 2-sample t-tests (0.95) were performed between all groups.

Results: Measurement results are summarized in Table 1.

All shades show mean flexural strength values above 800 MPa and there is no statistical significant difference between the tested groups (p>0.116).

Effect of Shading on Flexural Strength of Cubic Full-Contour Zirconia (cont.)

Conclusions: Due to the phase composition cubic zirconia ceramics have lower flexural strength compared to tetragonal zirconia which typically offers above 1000 MPa. The cubic crystal phase content is determined by stabilizing additives like Yttria but might also be changed by shading elements. For cubic zirconia it is important to ensure that incorporated shading elements have no detrimental effect on mechanical properties. For the investigated material light shades as well as intense shades offer an equivalent strength level.

Table 1

Shade	A1	A3.5	B2	C4	D3
Mean Flexural Strength (MPa)	844	809	817	863	812
Standard deviation (MPa)	76	132	120	108	132

3M Oral Care Summary:

Study Objectives: Color ions are used to shade 3M™ Lava™ Esthetic Fluorescent Full-Contour Zirconia and the impact of their concentration on flexural strength was studied. Shades with a low level of color ions (A1 and B2) and a large concentration (A3.5, C4 and D3) were compared.

Summary of Results: No statistical difference was observed in the flexural strength of the five (5) shades evaluated in this study. The results indicate that the concentration of color ions utilized to shade 3M Lava Esthetic Fluorescent Full-Contour Zirconia does not impact flexural strength. The shades evaluated in the study demonstrated flexural strength that meet the requirements for an ISO 6872:2016 Type II, Class 4 ceramic.

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