3M Science. Applied to Life.™

3M™ Chairside Zirconia

Technical Data Sheet

1. Introduction

The first 3M zirconia was introduced over 15 years ago – 3M™ Lava™ Frame, a high strength zirconia for veneered zirconia restorations. The next generation was 3M™ Lava™ Plus with increased translucency and a shading system based on dyeing liquids for high-strength full contour zirconia restorations. To have a super high translucent zirconia, fulfilling the user needs for high aesthetics combined with high strength, 3M™ Lava™ Esthetic Fluorescent Full-Contour Zirconia was introduced in 2016. With 3M™ Chairside Zirconia, 3M transfers its knowledge in zirconia from the dental lab to the dental office.

Evolution of Zirconia

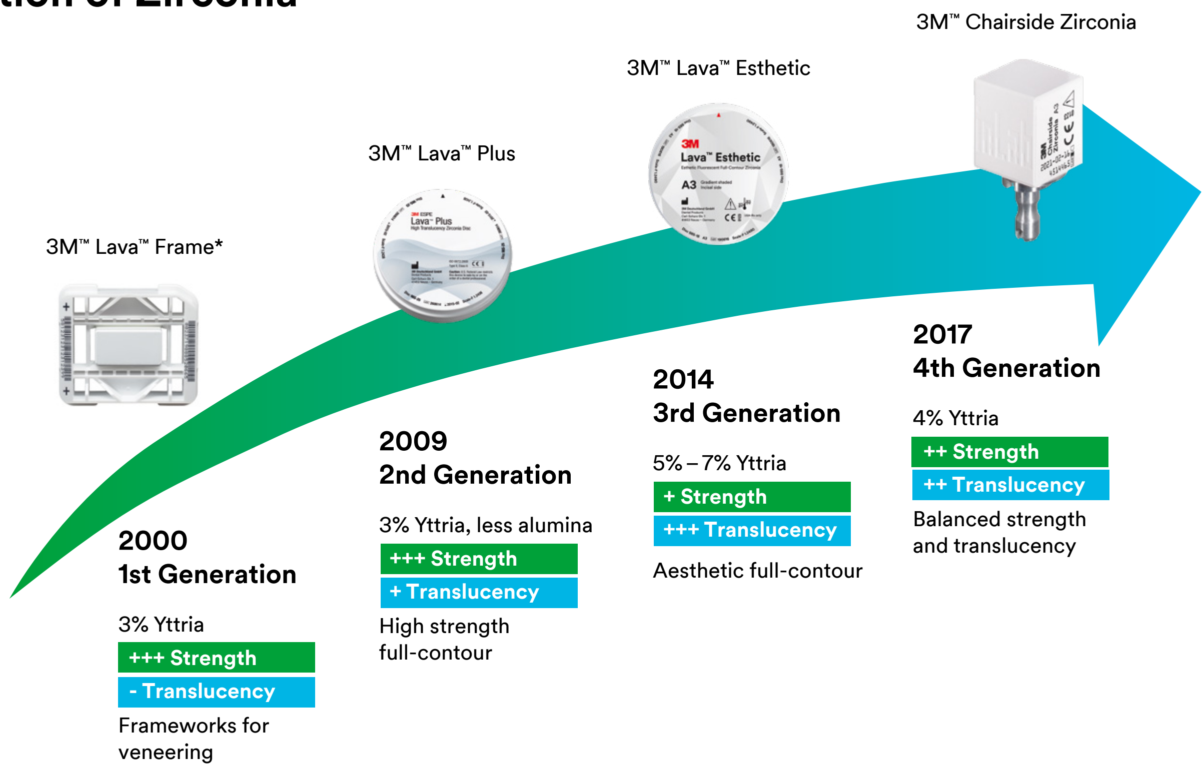

Figure 1: Evolution of zirconia

* No longer available

2. Product Description

3M™ Chairside Zirconia is a newly developed zirconia for dental use offering an optimal blend of strength and aesthetics. It can be fast fired in high temperature sintering furnaces, including the CEREC® SpeedFire furnace (Dentsply Sirona) and Programat® CS4 furnace (Ivoclar Vivadent).

3M™ Chairside Zirconia is a 4Y zirconia with a flexural strength of 1000 MPa (fast fired) and is qualified as Type II, class 4 according to ISO6872:2015.

Indications are anterior and posterior crowns, including crowns on implant abutments, anterior and posterior bridges.

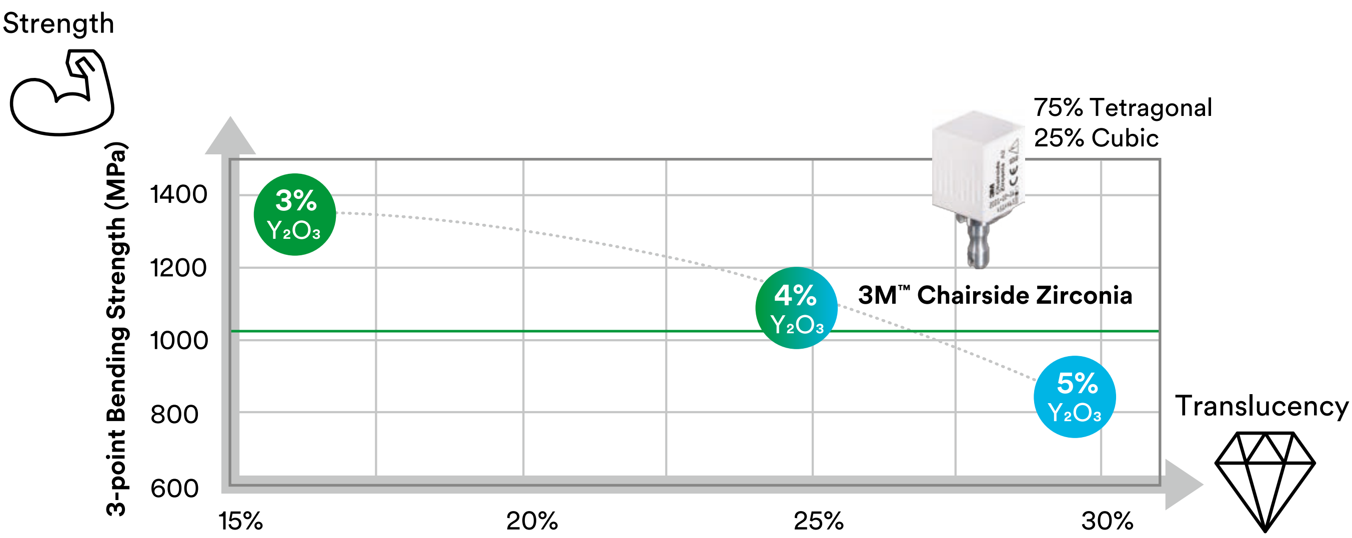

Figure 2: Illustration of strength and translucency of zirconia with increasing yttria content

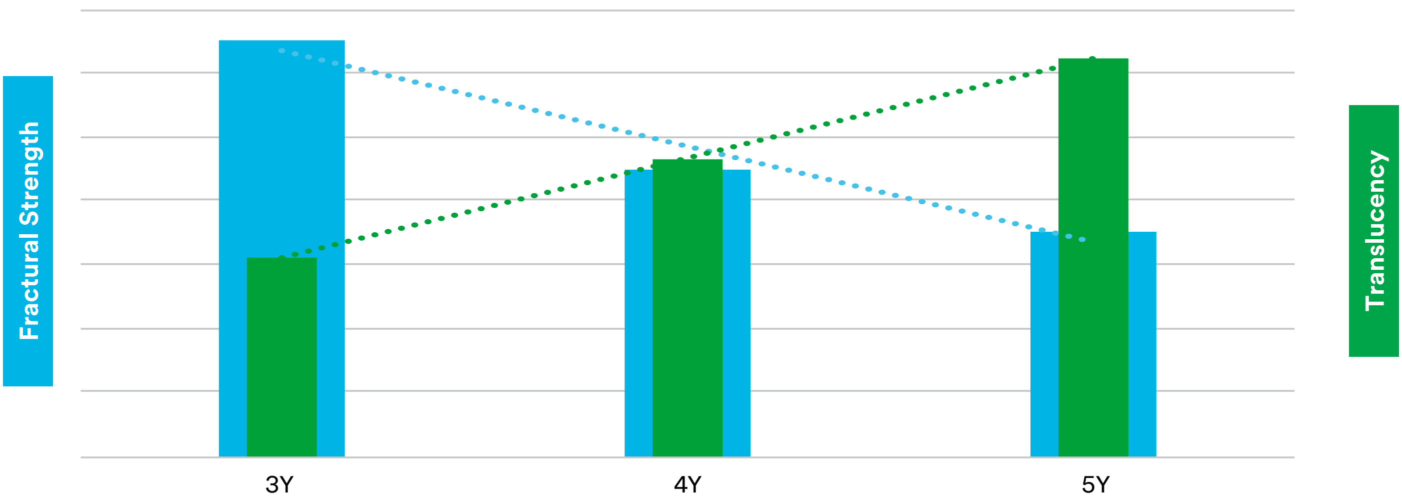

Figure 3: Strength and translucency correlation of zirconia generations

3M™ Chairside Zirconia

- Balanced strength and translucency
- Indicated from single unit restorations up to 3-unit bridges
- Short sintering time of ~20 min with CEREC® SpeedFire[1,2]
- Fast and easy polish or glaze finishing
- Simplified cementation
- Allows for scan to seat in one hour[1]
- Available in two pre-shaded block sizes in eight shades for easy shade matching
- Designed for shade match to VITA® classical shade guide.

3M™ Chairside Zirconia is the right choice for dentists who want to offer patients zirconia crowns in one session, with an emphasis on speed, fit and aesthetics.

3. Product and Material Properties

3.1 Composition and Phase Composition

One property of zirconia which can be modified by adding elements to the crystal structure is the shade. For use as material for dental applications, this aesthetic effect can be precisely controlled by the selection and the distribution of the elements in the zirconia. This homogenous distribution is also critical for not reducing the strength of the final material, another important factor for its use in dentistry. A highly aesthetic effect is only possible if the correct additives are selected. Through the use of both internal and external customer evaluations, each of the tooth shades was matched to the shades in the VITA® classical shade guide. Shade match is achieved by fine-tuning the ratio of the red, gray and yellow shading elements.

The key step to develop this new zirconia are changes to the microstructure of the zirconia material. Like 3M™ Lava™ Plus or 3M™ Lava™ Esthetic, 3M™ Chairside Zirconia is a polycrystalline zirconia that is stabilised with yttrium oxide (yttria). The difference is in the yttria concentration: five mole percent for Lava Esthetic, about three mole percent for Lava Plus and four mole percent for 3M™ Chairside Zirconia. To use four mole percent yttria results in a zirconia with a combination of properties that result in high strength, high translucency and a possibility to reduce the sintering time significantly in comparison to conventional zirconia.

Besides the chemistry, the phase composition influences the properties of the zirconia material. With 4mol% yttria content the phase composition of the sintered material is ~75% tetragonal and 25% cubic. This ratio results in a zirconia material having a high strength of 1000 MPa (fast fired) flexural strength, a fracture toughness of more than 6 MPa*m½ and a stable phase composition even under humid conditions (see Table 1).

	Flexural Strength	Fracture Toughness	Phase Composition	Monoclinic Phase after Hydrothermal Treatment
3M™ Chairside Zirconia	1000 MPa	6.4 MPa*m½	~75% tetragonal/ ~25% cubic	~0%

Table 1: Selected parameter of 3M™ Chairside Zirconia (3M internal data on file)

1. CEREC® SpeedFire furnace, restorations with particular designs (parameter integrated in CEREC® software; wall thickness 1.2 mm or less)
2. 19.6 min for small, thin walled crowns; 22.4 min for all other crowns

3.1.1 Why is Yttria added to Zirconia?

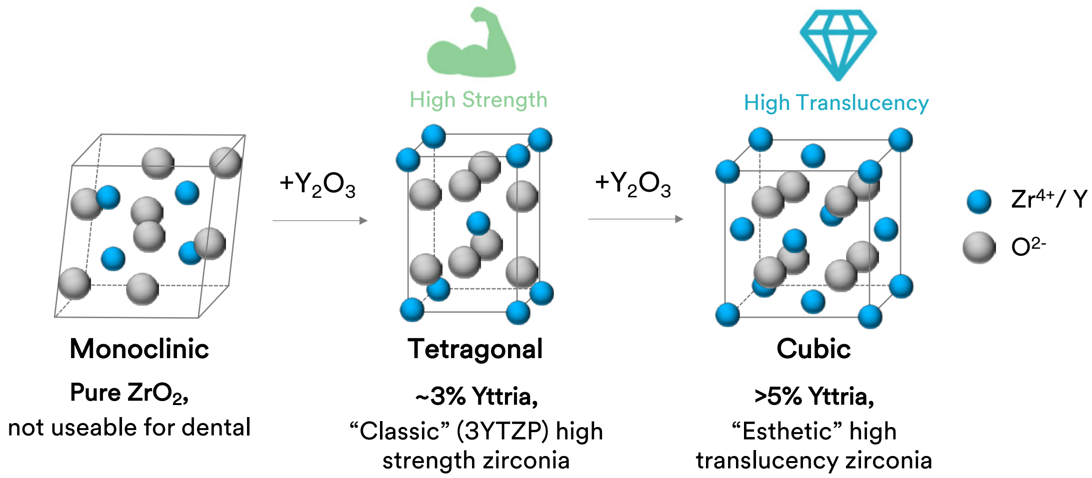

Figure 4: Yttria content determines strength and translucency by adjusting the phase composition

- In Zirconia, atoms can be arranged in three different ways (so called "crystal phases")
- Pure ZrO_2 is monoclinic and not usable for dental applications
- Yttria addition stabilises the tetragonal and the cubic phases
- At ~3% Yttria, the tetragonal phase dominates which maximises strength
- At 5% or more Yttria, the cubic phase starts to dominate which reduces strength but increases translucency

3.1.2 How does the Cubic Phase increase translucency?

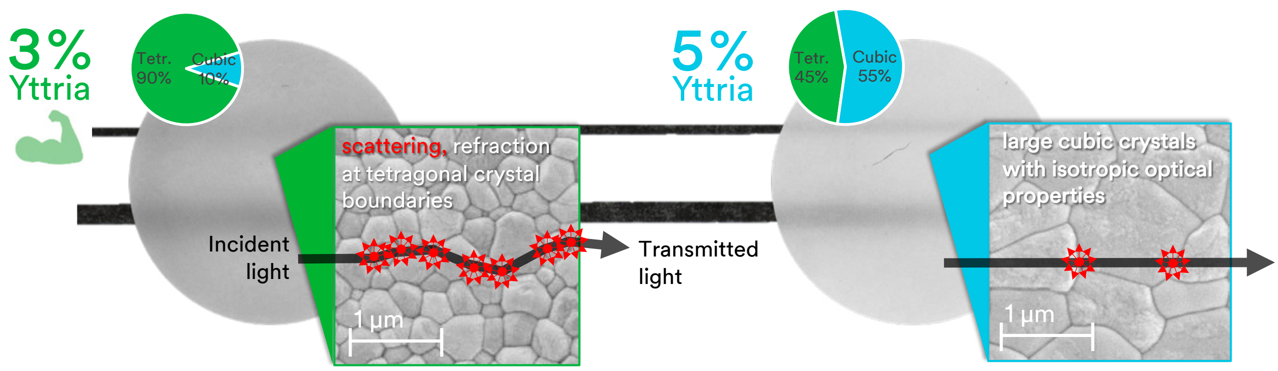

Figure 5: Cubic phase increases translucency by reducing light scattering and deflection.

Backlight image of 1 mm Zirconia discs positioned over two printed lines.

Left side: Low Translucency, blurred lines

- Light is scattered at crystal boundaries
- Deflected transmission by anisotropic (orientation dependent) optical properties of tetragonal crystals

Right side: High Translucency, clearer lines

- Less scatter due to less boundaries between the larger cubic crystals
- Less defection by isotropic optical properties of cubic crystals

3.1.3 How does the Tetragonal Phase increase strength?

Strength

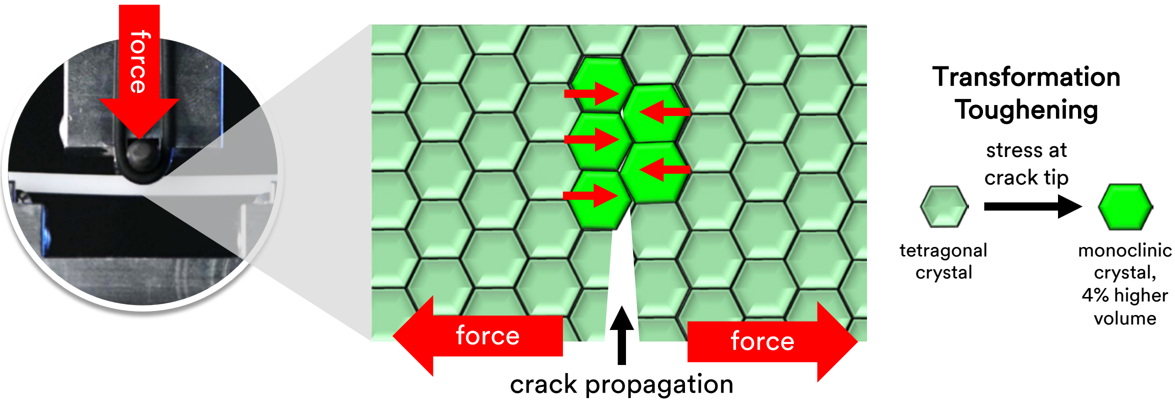

Figure 6: Tetragonal phase increases strength by hindering crack propagation through phase transformation

3.2 Material Properties

3.2.1 Flexural Strength

Flexural strength is measured by applying a load to a material specimen that is supported at each end and combines the forces found in compression and tension. The flexural strength is a measure of mechanical stability.

Flexural strength is measured according to ISO 6872:2015. Samples with 4 x 1.2 x 16 mm³ dimension with chamfer were polished with 20 µm diamond paste and tested in a mechanical testing device with 3-point bending method with 1 mm/min load rate until fracture. Flexural strength is calculated from fracture force, sample size and support geometry acc. ISO 6872:2015

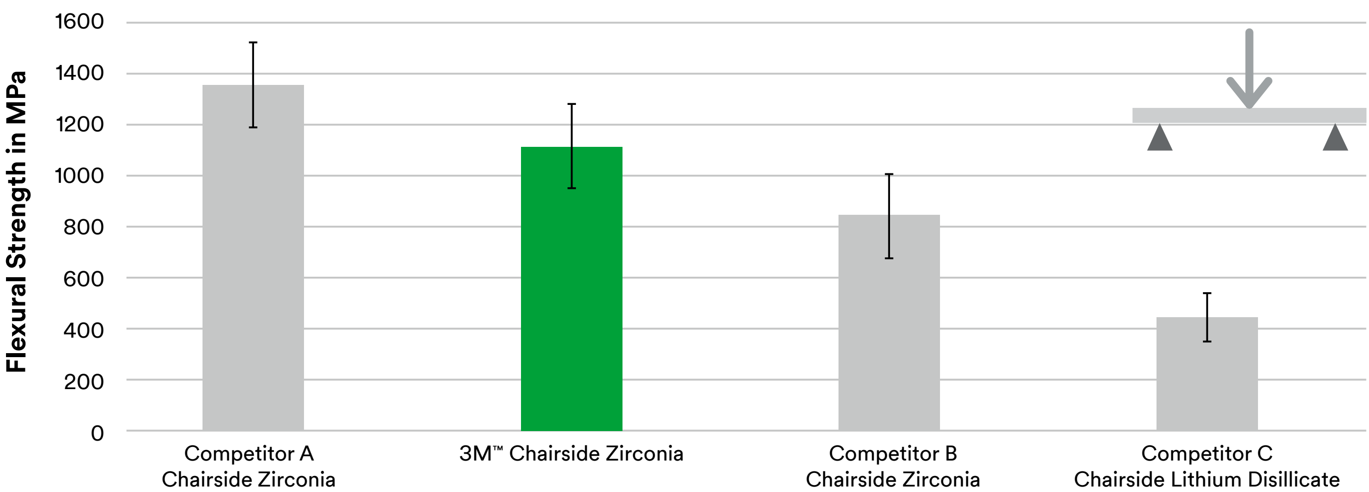

Figure 7: Flexural strength of 3M™ Chairside Zirconia in comparison to competitor material in shades A3.5

Source: 3M internal data on file

3.2.2 Fracture Toughness

The fracture toughness (K_{Ic}) of a material can be defined as the materials resistance against crack propagation. A sample bar is placed on a fixture that supports either end and the force is applied above a notch in the sample in a 3-point bending configuration similar to that used for flexural strength. A high fracture toughness reflects a high ability of a material to hinder crack propagation.

Fracture toughness is measured by fracture toughness test method (SNVB method) according to ISO 6872:2008. Samples with 4 x 3 x 16 mm^3 dimensions with chamfer were polished with 20 µm diamond paste, notched on tension side to around 1 mm notch depth and tested in a mechanical testing device with 3-point bending method with 1 mm/min load rate until fracture. Fracture toughness is calculated from fracture force, sample size, notch depth and support geometry acc. ISO 6872:2008.

The fracture toughness of 3M™ Chairside Zirconia is higher than lithium disilicate and on the same level as other high translucent cubic zirconia.

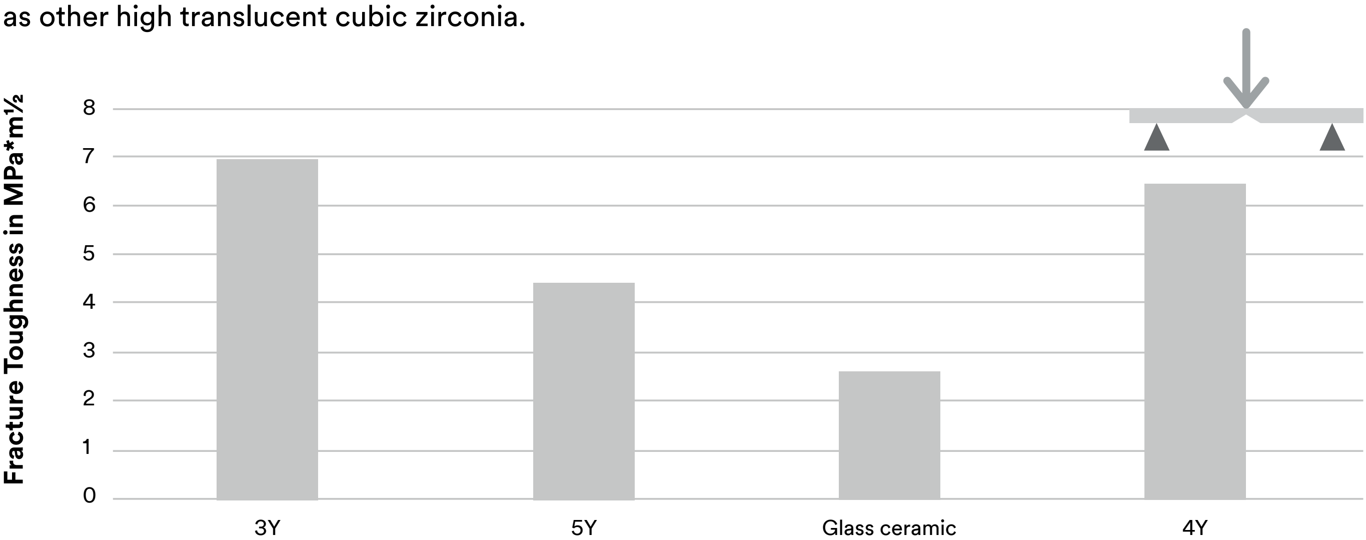

Figure 8: Illustration of fracture toughness of different zirconia classes and a lithium disilicate material
Source: 3M internal data on file

3.2.3 Translucency

The translucency of a dental material is, beside the shade, the main influencing factor on the aesthetics. Usually a translucency comparable to the natural tooth is desired. The translucency of a material is measured by using samples with 1 mm thickness and polished surfaces. A measure is the contrast ratio CR that is measured in remission with a spectrophotometer (X-Rite Color i7). A higher value for 1-CR means it correlates with a higher translucency.

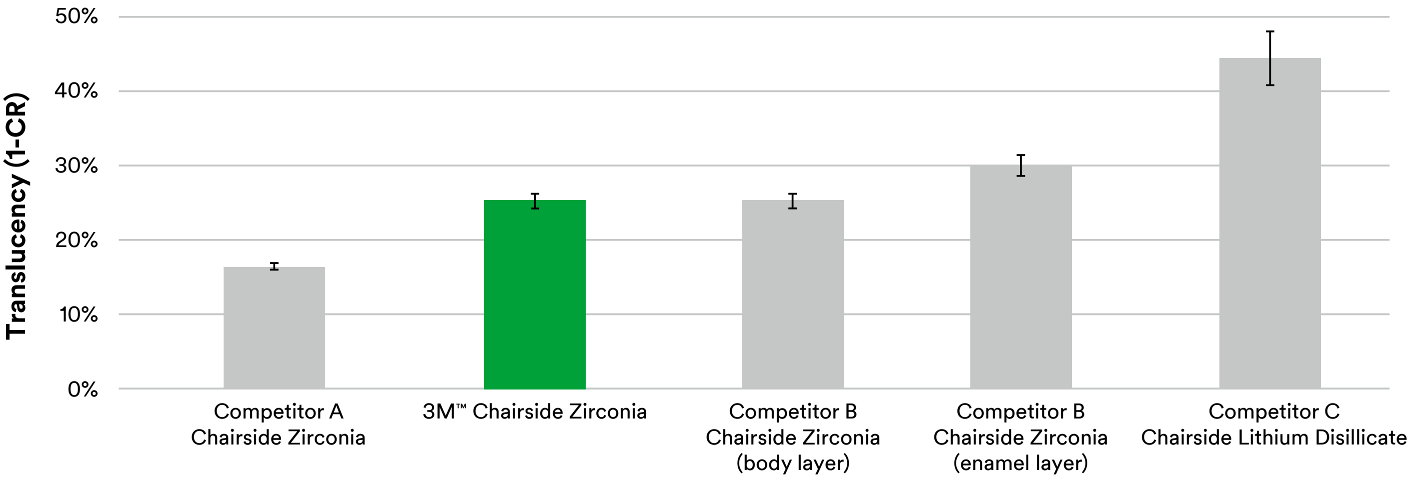

Figure 9: Translucency of 3M™ Chairside Zirconia in comparison to different competitor materials
Source: 3M internal data on file

3.2.4 Shear Bond Strength with 3M Cements

Additional measurements of shear bond strength were done at the University of Regensburg, Germany in a comparable setup.

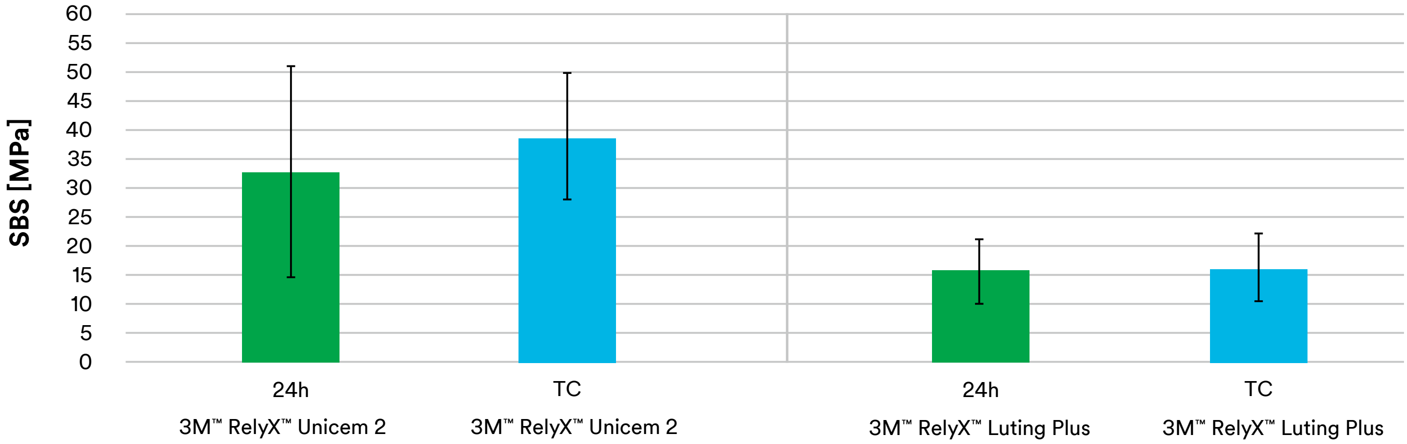

Figure 10: Adhesion of 3M™ Chairside Zirconia with two different cements
Source: 3M internal data on file

Shear bond strength (SBS) is a common method to measure and describe the adhesion of a dental restoration material to a surface/substrate.

Shear bond strength was determined (internally at 3M) between zirconia plates (20 x 10 x 2 mm^3) and CoCr cylinders (d = 5 mm, height = 3 mm). Zirconia surfaces were sandblasted (280 mesh alumina, air pressure) and the cylinders were mounted with 3M™ RelyX™ Unicem 2 Self-Adhesive Resin Cement and 3M™ RelyX™ Luting Plus Resin Modified Glass Ionomer Cement according to Instructions for Use. Cleaning before bonding was performed with alcohol. Shear bond strength was determined according to ISO TR 11405 with v = 1 mm/min after 24 hours and after thermocycling (TC 12000 x 5°C/55°C).

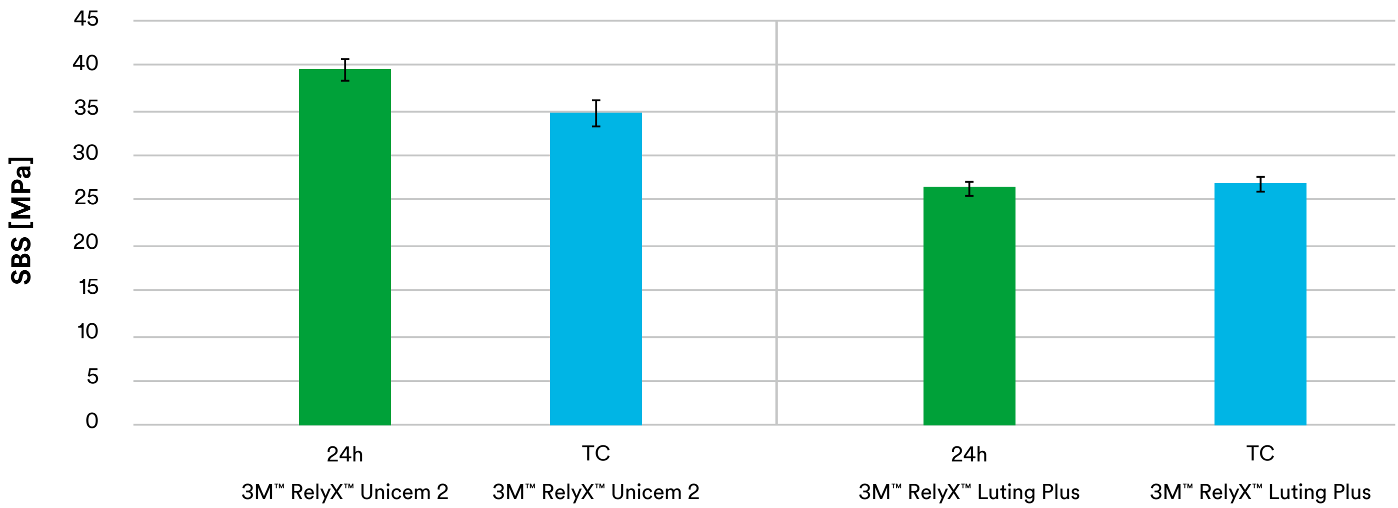

Figure 11: Adhesion of 3M™ Chairside Zirconia with two different cements
Source: 3M internal data on file

4. Workflow

3M™ Chairside Zirconia offers high aesthetics and a high flexural strength of 1000 MPa (fast fired), in combination with a fast and productive process.

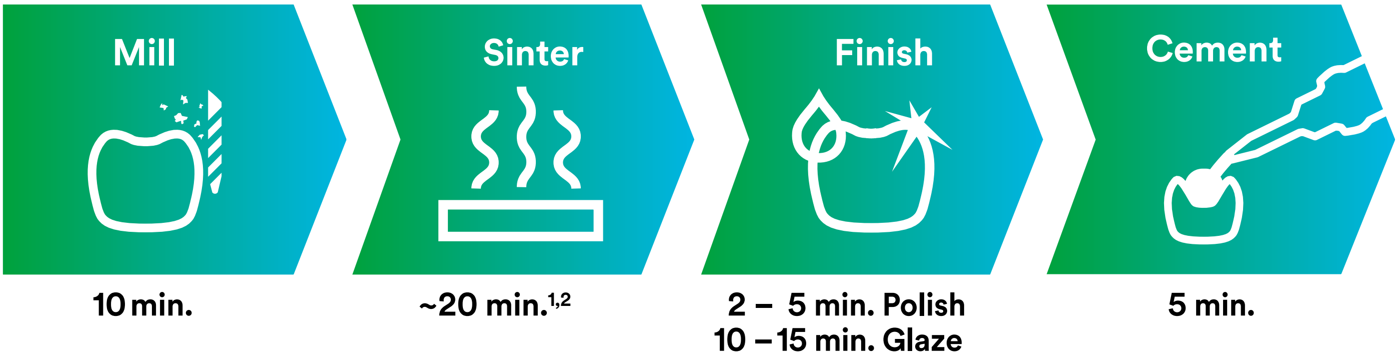

Figure 12: Overview on workflow and estimated times for the steps

5. Clinical Case

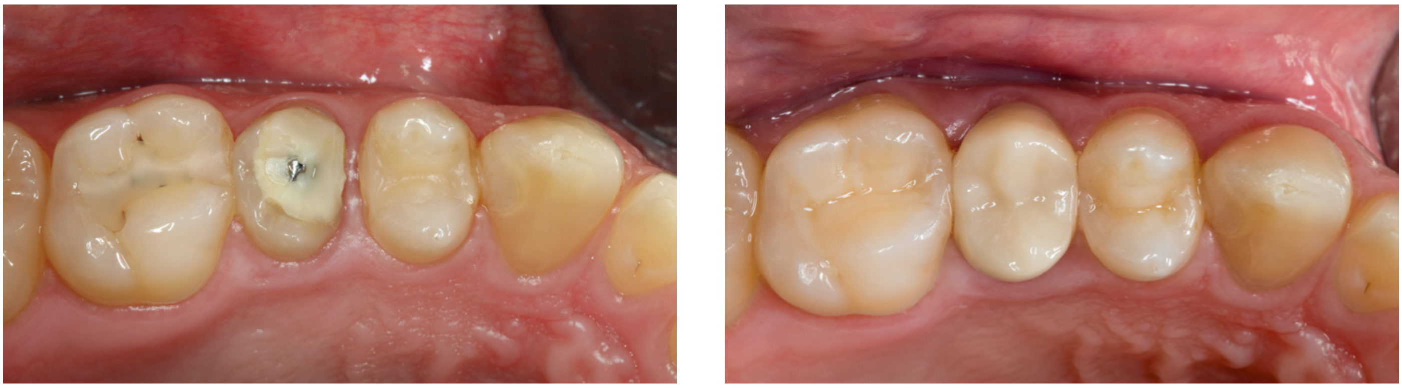

Figure 13: Initial and final situation of a replacement 5 and 6 with 3M™ Chairside Zirconia
Courtesy of Dr Gunnar Reich, Munich, Germany.

6. Technical Data Overview

	3M Chairside Zirconia
3-point Bending Strength (ISO 6872)	1000 MPa
Fracture Toughness (SEVNB ISO 6872:2008)	6.4 MPa*m½
Vickers Hardness	>1200
Coefficient of Thermal Expansion (25 °C – 500 °C) (ISO 6872)	10.4 +/- 0.5 1/K
Density (ISO 13356)	> 6.05 g/cm3
Translucency (1-CR, unshaded material, 1 mm)	32 %
Alumina content	0.1 wt%
Yttria content	~4mol%
Available shades	Bleach, A1, A2, A3, A3.5, B1, C1, D2
Available block sizes	Crown: 20 × 16 × 19.5 mm Bridge: 39 × 16 × 19.5 mm

Table 2: Overview of technical parameters of 3M™ Chairside Zirconia

Source: 3M internal data on file

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