

Aevra

Dental Zirconia Ceramics

[Scientific Documentation]

Reliable Materials Expert

UPCERA

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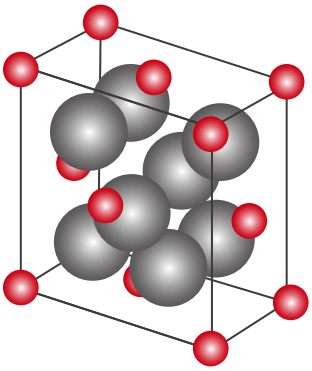
01 Introduction

1.1 Overview

Ceramic has long been recognized as an ideal material for matching the aesthetic properties of natural teeth. When confronted with all-ceramic options such as zirconia, glass-ceramics, and composite resin ceramics, dentists frequently face the challenge of balancing "strength" and "aesthetics": posterior tooth restorations prioritize robustness and durability, while anterior restorations emphasize translucency and natural appearance. Is there a material that can excel in both aspects and transcend the performance limitations of traditional materials? Aevra multi-layer gradient zirconia enables controllable aesthetics throughout the entire process from powder to final restoration, empowering dental technicians to freely define the boundaries of aesthetics and functionality.

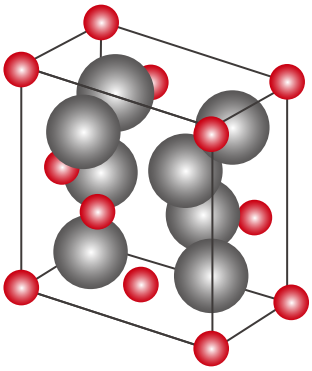
1.2 Scientific Background

Zirconia constitutes a high-performance ceramic material renowned for its exceptional strength and toughness. However, unmodified pure zirconia exists in the monoclinic phase at ambient temperature, and it undergoes a reversible phase transformation upon thermal cycling (heating and cooling), accompanied by a substantial volumetric change (approximately 3–5%). This volumetric fluctuation induces internal residual stresses within the material, rendering it prone to cracking post-sintering. Consequently, unmodified pure zirconia is not suitable for direct practical applications.



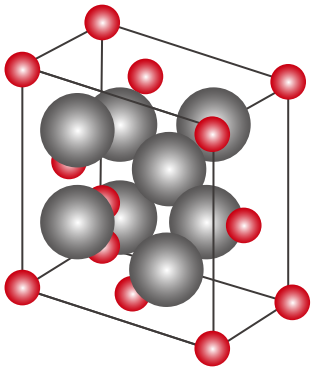
c-ZrO_2

ρ: 6.27g/cm^3



t-ZrO_2

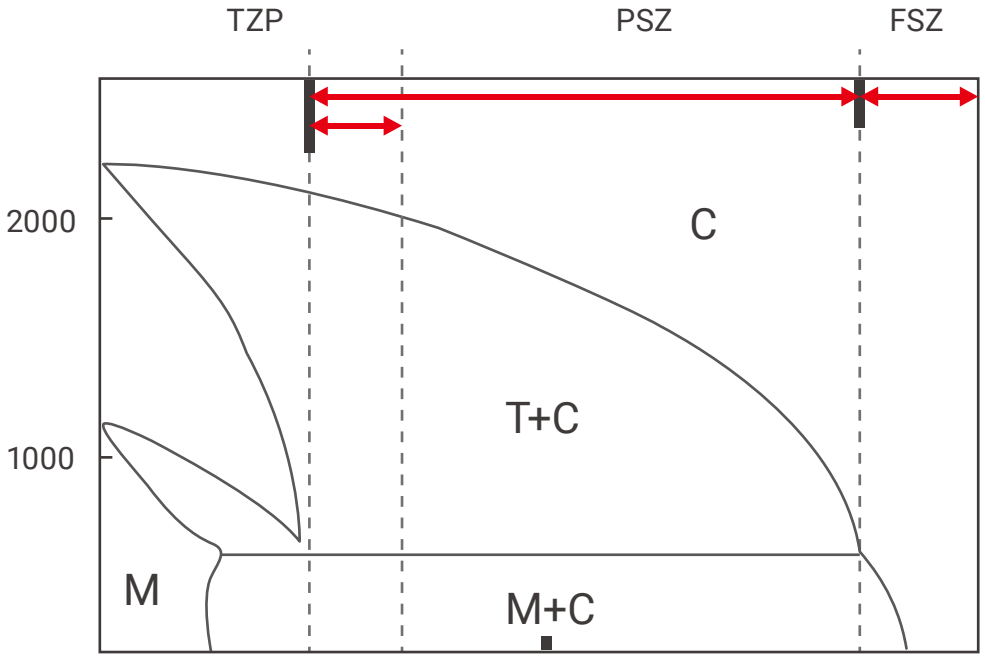
ρ: 6.10g/cm^3



m-ZrO_2

ρ: 5.65g/cm^3

To address the phase transformation challenge of pure zirconia, researchers incorporate stabilizers (e.g., yttrium oxide, Y_2O_3) into the system. Specifically, Y^{3+} ions substitute for a fraction of Zr^{4+} ions within the crystal lattice, yielding a solid solution. Such doping disrupts the translational periodicity of the crystal lattice, thereby enabling zirconia — which is thermodynamically stable in the monoclinic phase at ambient temperature—to persist in the metastable tetragonal phase at room temperature.



ZrO_2—Y_2O_3 binary

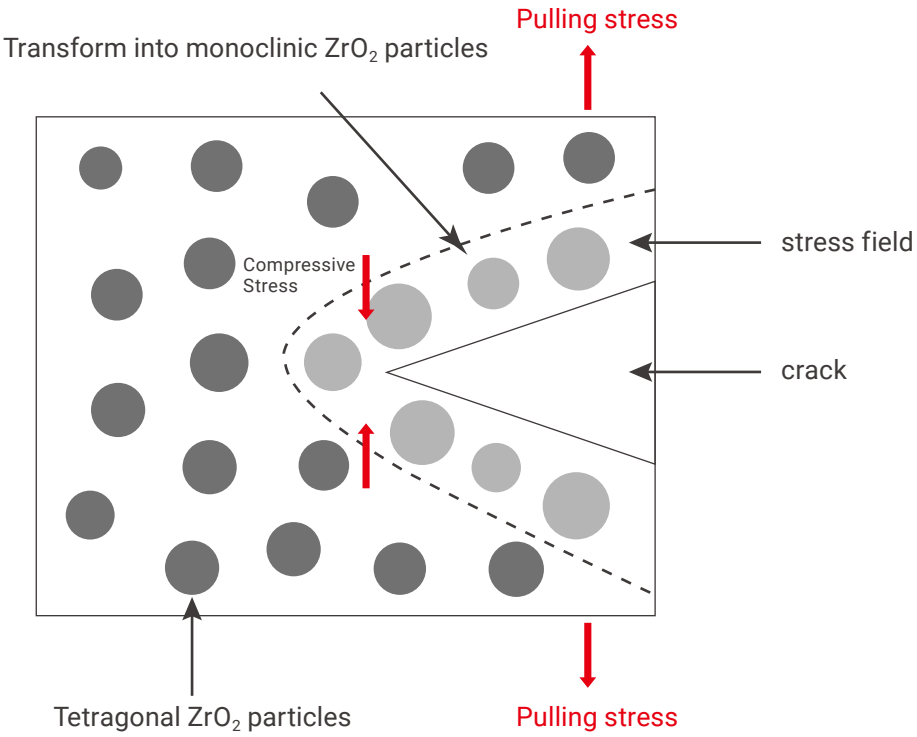
The difference between ion radius and zirconium ion radius is less than 40%: CaO, MgO

Yttria-stabilized zirconia (YSZ) is widely dubbed "ceramic steel" in the dental domain, with its core merits manifesting in the following aspects:

(1) Excellent mechanical properties[1]:

High strength and toughness: its flexural strength ranges from 600-1200 MPa, which is much higher than that of alternative dental ceramics (e.g., 100-400 MPa for glass ceramics). This enables the fabrication of posterior restorations, multi-unit bridges and even implant substructures, all of which are subject to high occlusal forces.

The high toughness of zirconia is mainly due to its unique "phase transformation toughening" mechanism. This is a spontaneous and microscopic energy dissipation process, which can effectively prevent the crack from spreading. It can be thought of as a "micro-crack self-healing system" built into the material. When the material is subjected to external force and the crack begins to expand, the tip of the crack is a region with highly concentrated stress. The stress field in front of the crack tip reaches the critical trigger value of tetragonal phase (T) transforming into monoclinic phase (M). The metastable tetragonal grains in this region rapidly undergo t→m phase transformation. The volume expansion of ~4% accompanied by phase transformation will produce a compressive stress field in the microscopic region. This new compressive stress field is just opposite to the tensile stress field that leads to crack propagation, thus: It counteracts the tensile stress at the crack tip, effectively "clamps" the crack, making it difficult to move on, and may even stop the crack from spreading or change its direction.



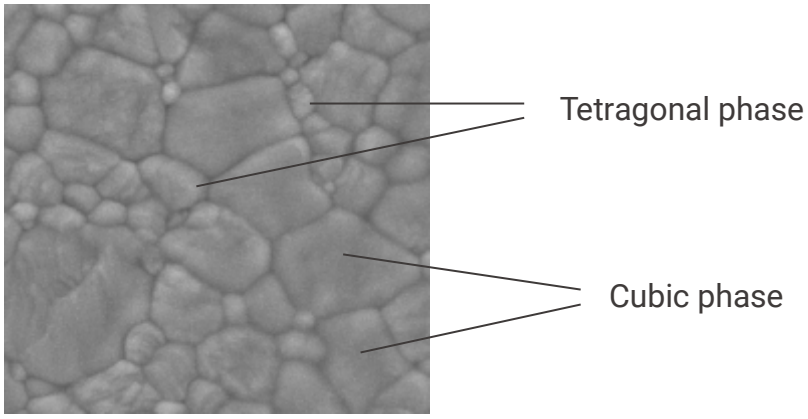
(2) Excellent biocompatibility:

Zirconia is an inert biomaterial characterized by non-toxicity, non-allergenicity, and non-irritation to human tissues, thus being widely recognized as a clinically safe dental biomaterial.

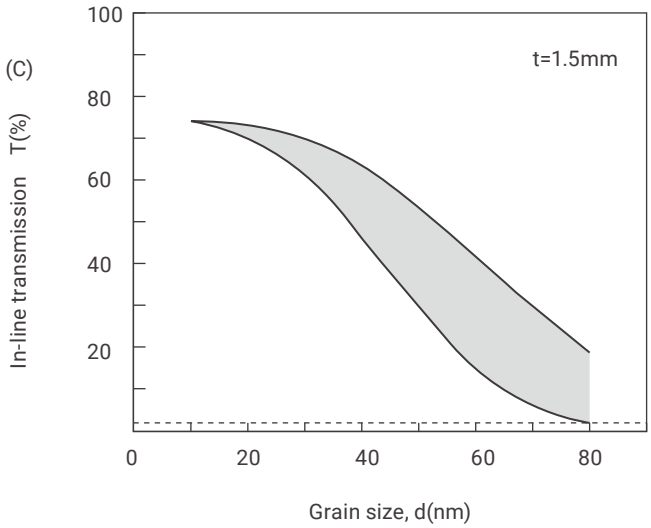
Zirconia (ZrO_2) is stabilized by mixed ionic-covalent bonding between Zr^{4+} and O^{2-} ions, which exhibits exceptionally high bond energy (requiring substantial energy input for dissociation). Within the complex oral aqueous microenvironment (encompassing Cl^- , H^+ , OH^- , proteins, enzymes, etc.), zirconia maintains a highly stable lattice structure, resisting dissolution, hydrolysis, and corrosion. In contrast to metallic alternatives (e.g., cobalt-chromium (Co-Cr) alloys and even titanium alloys), zirconia does not undergo ionic leaching or electrochemical corrosion—this prevents continuous release of metallic ions into adjacent tissues.

(3) Favorable aesthetic performance [2]:

The aesthetic merit of zirconia stems from its biomimetic optical properties: it replicates the light transmittance, scattering, and reflection behaviors of natural dentition. By regulating grain size and crystalline phase content, zirconia achieves a balanced integration of high mechanical strength and high optical translucency—two properties that are often mutually exclusive in conventional dental ceramics.



The crystal structure of cubic phase of zirconia is isotropic (that is, the optical properties in all directions are consistent), while the tetragonal phase is anisotropic. The isotropic cubic phase will not cause birefringence of light, thus greatly reducing the internal light scattering and significantly improving the transparency.



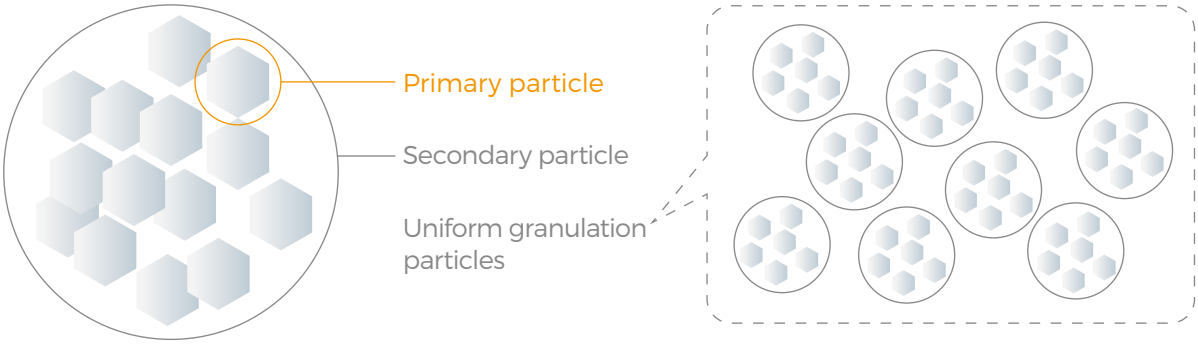
The grain size directly affects the light scattering. When D < λ, the incident light has high transmittance. When D≈ λ, the light transmittance is low.

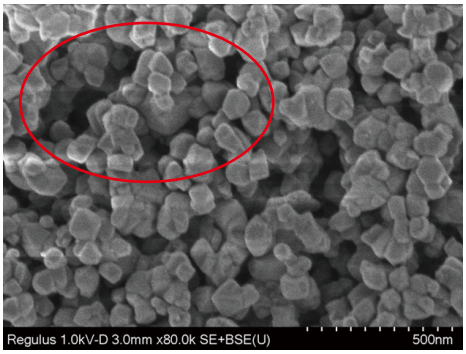


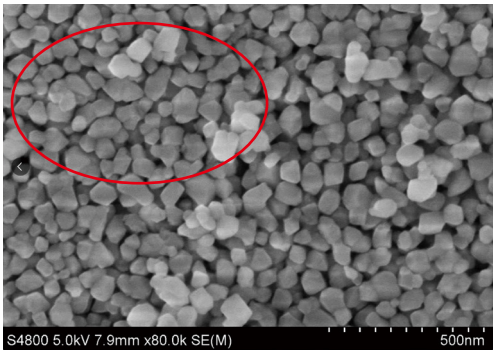
1.3 Sinocera Powder Technology

1.3.1 UPD (Uniform Particle Dispersion) Technology

The initial dispersion of primary nanoparticles within the secondary agglomerated powder is critical for achieving uniform green-body density and consistent sintering kinetics. Sinocera's new UPD Powder Technology enables the production of high-purity zirconia with controlled defect levels, thereby enhancing both mechanical strength and optical translucency. This improved powder homogeneity promotes synchronized and uniform grain growth during sintering, which ultimately determines the translucency and overall esthetic quality of the final ceramic restoration.





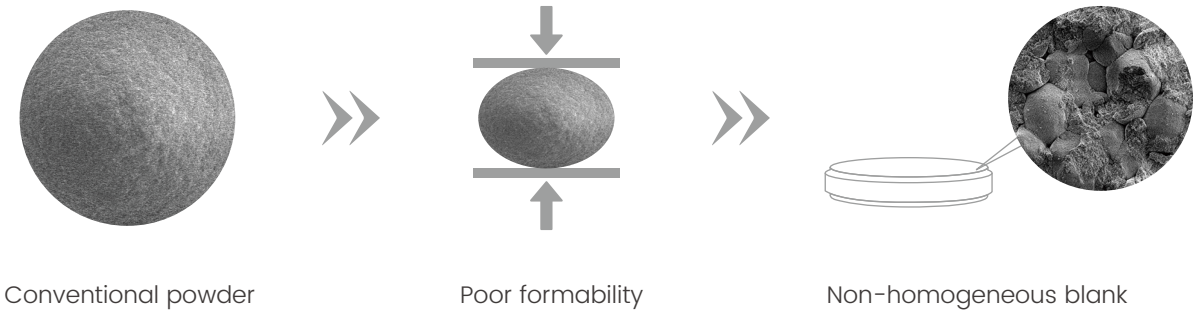




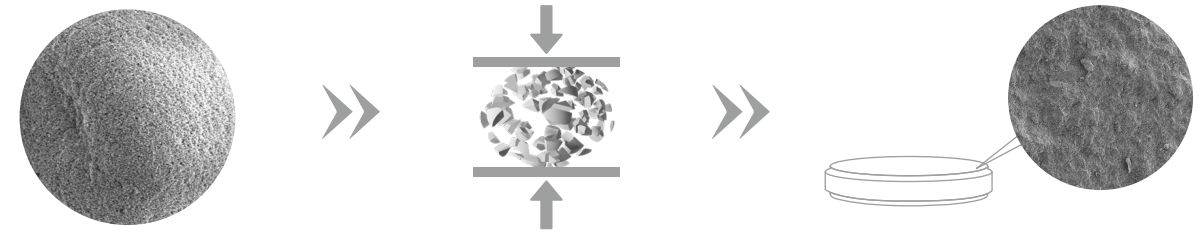
1.3.2 CSG (Centrifugal Spray Granulation) Technology

The surface porosity of primary agglomerated particles is fundamental to achieving optimal moldability and uniform compaction of zirconia green bodies. This parameter governs the consistency of grain growth and the likelihood of defect formation during sintering, ultimately shaping the balance between mechanical strength and esthetic performance in the final restoration.

With the integration of Sinocera's new CSG technology and UPD processing, the zirconia powder attains improved porosity and sphericity, promoting a more homogeneous green body structure and enhancing the density uniformity of the final zirconia blanks.



Conventional powder　　Poor formability　　Non-homogeneous blank



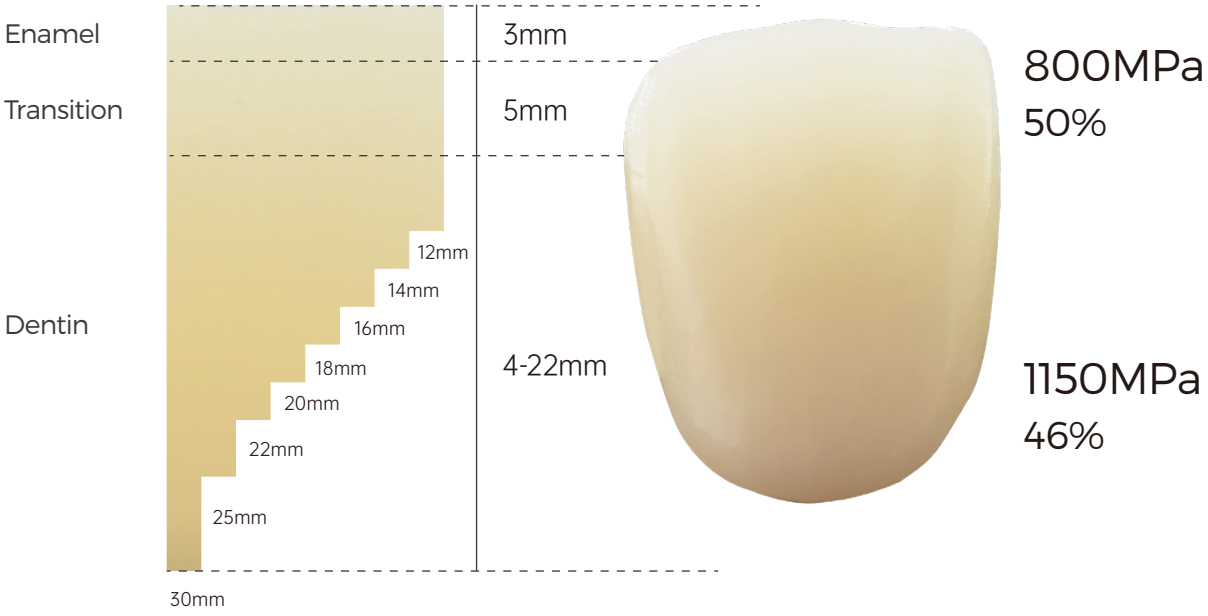
Sinocera new powder　　Good formability　　Homogeneous blank

02 Product Description

2.1 Product Specifications

2.1.1 Gradient

Aevra features innovative multi-gradient technology. Available in 12, 14, 16, 18, 20, 22, 25 and 30mm heights.



2.1.2 Shades





2.2 Indications

Aevra is a dental zirconia material which exhibits high optical translucency, making it a preferred option for all-ceramic dental restorations that integrate both aesthetic appeal and functional performance. Its clinical indications include:


Onlay/Inlay


Veneer

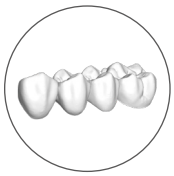

Crown

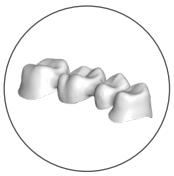

Substructure Crown


Implant-supported Single Unit


3-unit Monolithic Bridge


3-unit Substructures


Multi-unit Monolithic Bridge(≥4-unit)


Substructures Multi-unit Bridge(≥4-unit)


Implant-supported Multi-unit/Fixed Complete Dental Prosthesis

03 Composition & Microstructure

3.1 Composition

Layer	Y_2O_3	Fe_2O_3	Er_2O_3	MnO
Incisal	9-9.7%	0.00-0.05%	0.05-0.20%	<0.05%
Body	8-9%	0.00-0.05%	0.10-0.25%	<0.05%
Cervical	7-8%	0.00-0.10%	0.15-1.00%	<0.05%

3.2 Microstructure

Materials and methods:

SEM image analysis of the structure of densely sintered samples made of Aevra zirconia after polishing and thermal etching.

Results

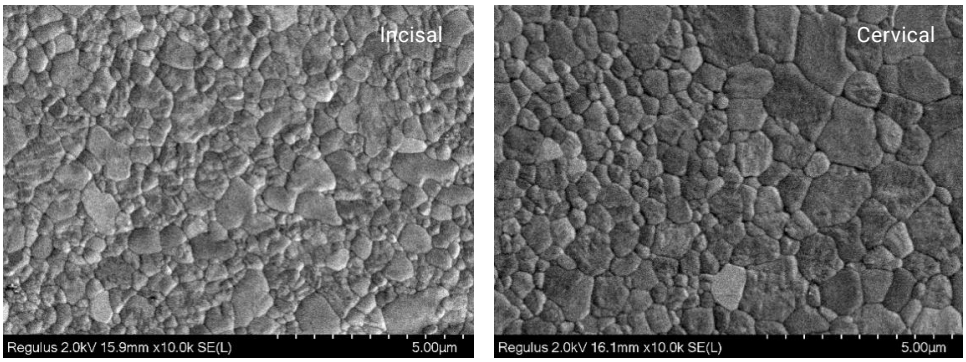


Fig. SEM of incisal and cervical part of Aevra zirconia blank

Source: Internal Study, Sinocera-Upcera R&D Department

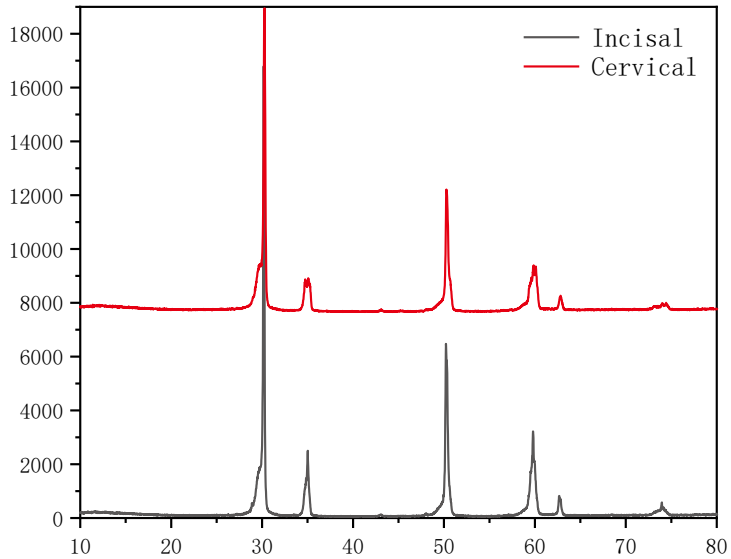


Fig. XRD of incisal and cervical part of Aevra zirconia blank

Source: Internal Study, Sinocera-Upcera R&D Department

Conclusion:

From the cervical to the incisal region, as the yttria content increases, the cubic phase fraction gradually rises from 50% to 60%. Given that the cubic phase possesses an isotropic structural nature, the enhanced isotropy of the material mitigates light scattering within the matrix—this effect consequently facilitates the improvement of the material's optical translucency. To balance the aesthetic and mechanical performance of the product, Aevra adopts a composite system of 4Y-PSZ and 5Y-PSZ. These two powder components exhibit excellent sintering compatibility: this characteristic allows the material to simultaneously enhance its aesthetic performance while retaining clinically applicable mechanical properties.

3.3 Technical Data



Yttria content	Gradient distribution equivalent to 4Y–5Y zirconia
Translucency (1mm, transmittance)①	46%-50%
Aevrage biaxial flexural strength②	＞1100MPa
Fracture toughness②	>4MPa·$m^{1/2}$
Density after sintering②	≥6.0g/cm^3
CTE (25-500℃) ②	(10.5±0.5)×$10^{-6}k^{-1}$
Monoclinic phase content of accelerated aging surface②	<5%
Chemical solubility after sintering②	<100μg/cm^2
Radioactivity②	⩽1.0Bq/g

Remarks: ① According to: ISO 6504-3 ② According to: ISO 6872:2024

04 Product Performance

4.1 Physical and Mechanical Properties

4.1.1 Strength

The mechanical strength of dental ceramic materials is a fundamental prerequisite for their application as load-bearing dental prostheses—analogous to the reinforced concrete framework of a building, it dictates the prosthetic longevity in the demanding mechanical environment of the oral cavity. For clinicians and dental technicians, high-strength materials provide expanded design latitude and more predictable clinical outcomes, enabling the implementation of more complex, esthetically refined prosthetic designs.

To precisely define the clinical indications of the Aevra zirconia material, the incisal, cervical and average strength of Aevra were measured using a consistent testing protocol—this approach ensures the reliability and consistency of the material's performance.

Materials and methods:

The biaxial flexural strength was measured according to ISO 6872. Prepare 10 discs having a thickness of (1.2±0.2) mm and a diameter of (14±2) mm. Final grind each specimen through diamond-embedded media having a nominal grit size of 30 um to 40 um and final polish on media having 15 um to 20 um diamond grit.

Results

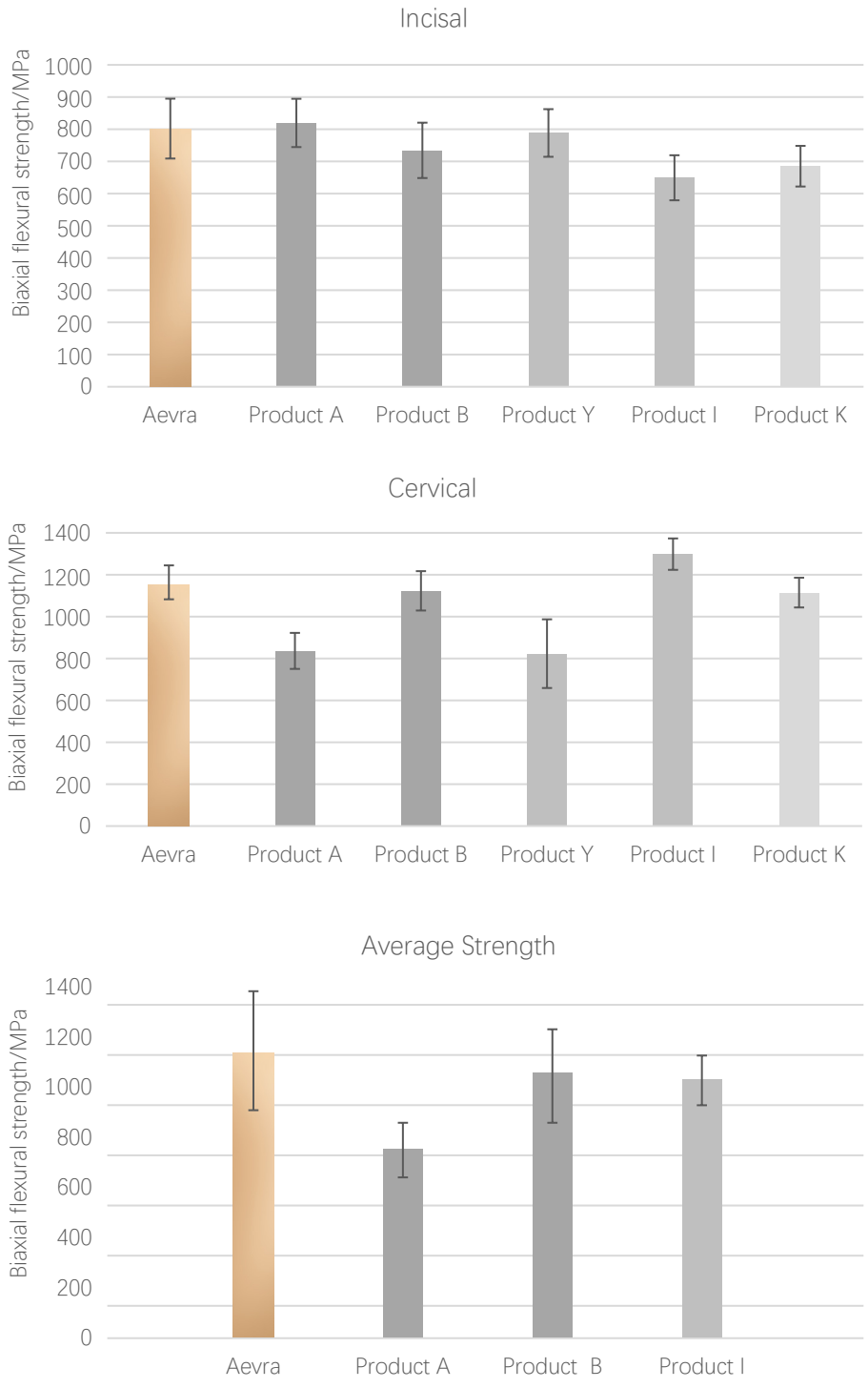


Fig. Mean values for biaxial flexural strength of multilayer zirconia

Source: Sinocera-Upcera R&D Department, according to ISO 6872:2024.

Conclusion:

In accordance with ISO 6872:2024, Aevra demonstrated an average biaxial flexural strength exceeding 1100 MPa, meeting the mechanical requirements for multi-unit fixed dental prosthesis (FDP) applications. Compared with other commercially available multilayer zirconia , Aevra exhibited more balanced mechanical performance from the incisal region to the cervical region. The test results indicate that Aevra achieves an excellent balance between esthetic performance and mechanical durability.

4.1.2 Grain Boundary Features

To achieve multi-layered, gradient zirconia materials with superior esthetic performance, manufacturers commonly blend zirconia powders containing different yttria (Y_2O_3) contents in specific ratios. However, variations in yttria concentration lead to inconsistent grain growth kinetics during sintering. In addition, the mixing of secondary particles results in microstructural heterogeneity after sintering, which can induce residual internal stresses and increase the risk of mechanical failure under relatively low loading conditions [4].

Materials and methods:

SEM image analysis of the structure of densely sintered samples made of Aevra and other zirconia blanks after polishing and thermal etching.

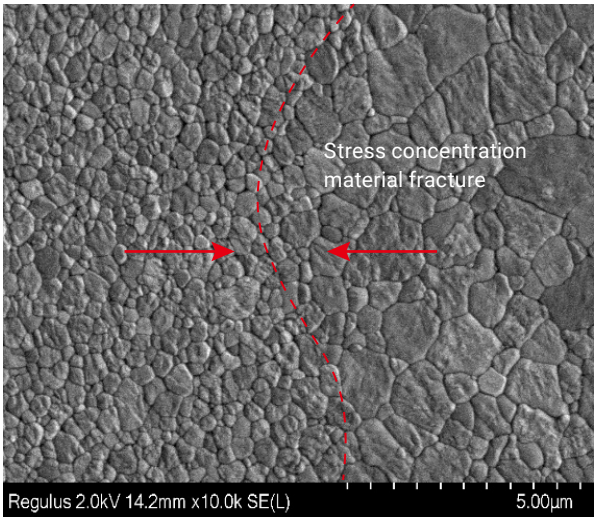


Fig. SEM of Product A zirconia blank in cervical region

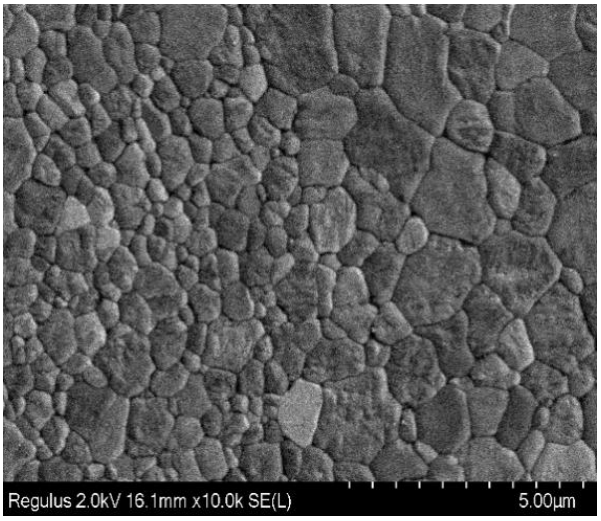


Fig. SEM of Aevra zirconia blank in cervical region

Source: Internal Study, Sinocera-Upcera R&D Department

Conclusion:

Microstructural analysis reveals pronounced grain boundary features in Product A, which are considered a primary factor contributing to its reduced mechanical strength. In contrast, Product I exhibits significantly finer grain sizes in the cervical region, providing high mechanical strength but at the expense of optical translucency. Aevra, however, adopts a co-sintering strategy by blending 4Y- and 5Y-PSZ powders with more compatible sintering behavior. Micromorphological observations demonstrate a more homogeneous grain size distribution after sintering, enabling an optimized balance between mechanical strength and translucency.

4.1.3 Machinability

Good marginal fit ensures a precise fit between the restoration and the prepared tooth or gingival tissue, minimizing the infiltration of saliva, bacteria, and food debris. This characteristic effectively reduces the risk of secondary caries and tooth sensitivity. Stable marginal integrity also extends the lifespan of the restoration by reducing water infiltration, thus slowing down the hydrolytic demineralization process. Furthermore, a well-fitting restoration margin ensures even distribution of occlusal forces, avoiding stress concentration and reducing the risk of restoration breakage due to uneven occlusion.

Materials and methods:

Test of CAM machinability using "merlon" geometry. For enhanced evaluation of the CAM machinability and the reproducibility of the virtually designed margin areas of Aevra zirconia blank, seven "merlons" (specimen geometry with four merlons, see figure) with wall thicknesses of 0.2 mm or 0.3 mm or 0.4 mm were produced using a CAD/CAM system. The same milling strategy was used for all specimens. Finally, the specimen geometries (in the three wall thicknesses) were visually examined and the merlons of the respective specimens checked for defects. The result chart shows the success rate of the merlons per specimen geometry for each material type and wall thickness.

Results

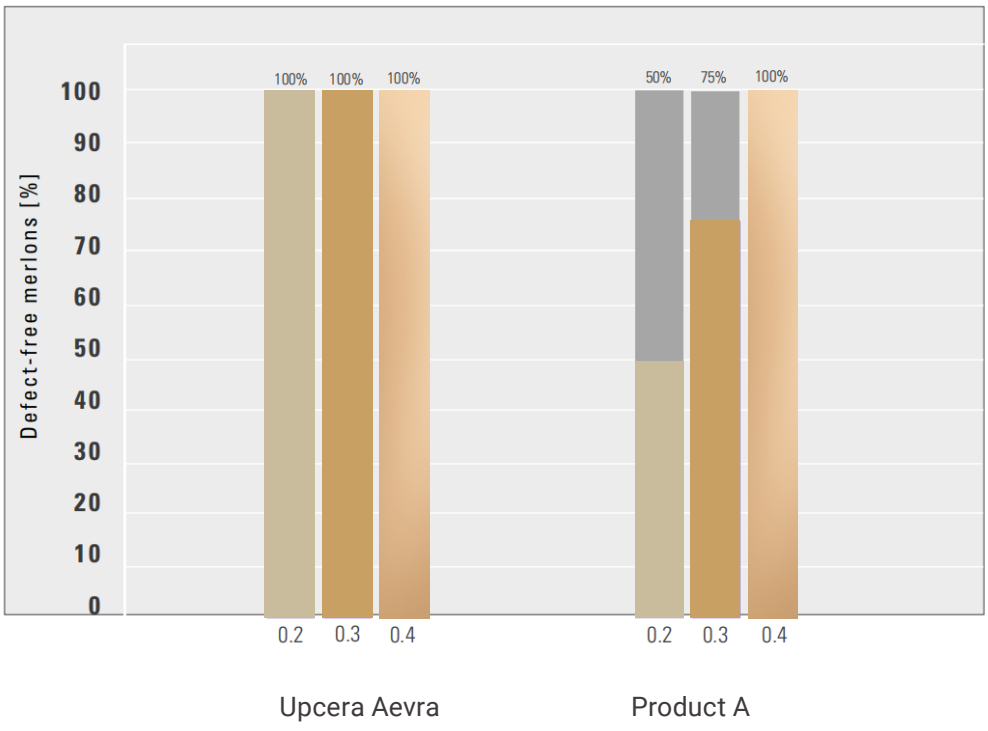


Fig. CAM machinability of the different zirconia materials

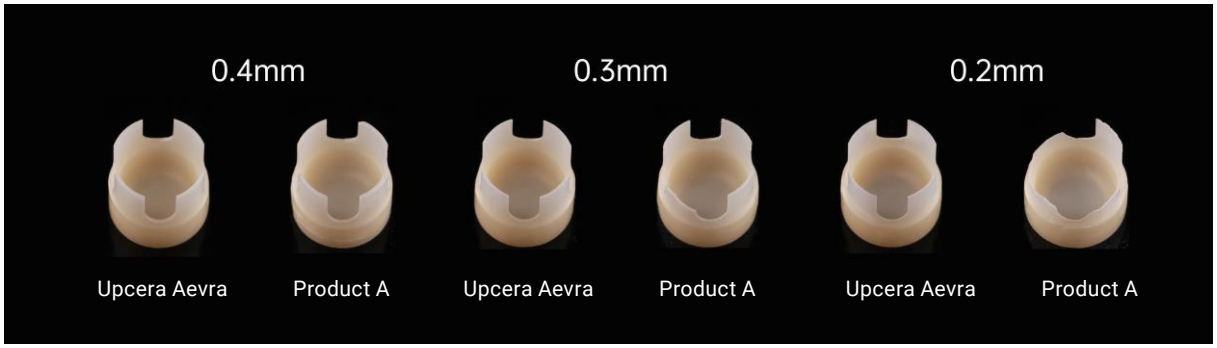


Fig. "Merlon" geometries made of zirconia blanks with different wall thicknesses

Source: Internal Study, Sinocera-Upcera R&D Department

Conclusion:

According to ISO 18675-2022, Upcera Aevra Ziconia Blank and Product A with thicknesses of 0.4 mm, 0.3 mm, and 0.2 mm were milled using CAD/CAM technology to evaluate the material's precision machinability. This test shows that the use of Upcera Aevra enables the fabrication of extremely exact, precision-fit restorations, thanks to the high edge stability. For relatively thin restoration edges (cf. 0.2 mm), Aevra ensures favorable processing outcomes.

4.2 Translucency

To develop multi-layer, gradient zirconia materials with superior esthetic performance, the translucency of dental ceramics is critical, as it directly influences the ability of restorations to replicate the optical behavior of natural teeth.

Materials and methods:

Translucency was evaluated using a spectrophotometer in accordance with ISO 6504-3. Zirconia specimens with a thickness of 1.0 mm were prepared and polished to a high-gloss finish on both sides. For each material series, the reported value represents the mean of five specimens.

Results

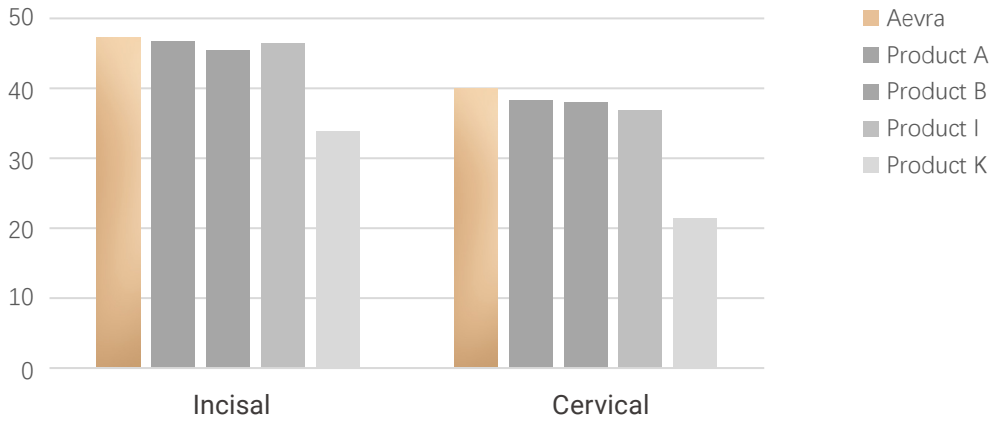


Fig. Translucency of the incisal and cervical part of different zirconia materials

Source: Internal Study, Sinocera-Upcera R&D Department

Conclusion:

The translucency values obtained in this study are comparable only within the parameters of this test setup, as they are influenced by specimen thickness, measuring equipment, aperture size, and shade. Within these limitations, Aevra zirconia demonstrated translucency levels similar to the reference materials.

Aevra's performance reflects its composite architecture, which combines 5Y-PSZ and 4Y-PSZ to balance incisal translucency with dentin masking capability. The incisal layer exhibits translucency comparable to Product A, while the cervical region shows values consistent with other materials. This design enables favorable light transmission in the incisal zone and effective masking of dark underlying substrates in the dentin zone (e.g., discolored tooth structures).

4.3 Deformation

For multilayer zirconia, the gradient distribution of yttria and colorants may create density variations in the cervical region during molding and pre-sintering. These differences can lead to uneven shrinkage after sintering (including veneering), potentially causing deformation and compromising the final restoration. Warpage—defined as the percentage ratio of warpage height to sample length—is a key indicator of deformation, with lower values reflecting better dimensional stability and marginal fit.

Materials and methods:

Four samples were fabricated from a CAD model (w = 10 ± 1.0 mm; B = 2 ± 0.5 mm; L = 70 ± 2.0 mm). A corresponding control model was milled using a CNC system. Individual test samples were produced with sintering enlargement applied to eliminate scanning-related inaccuracies. Final deformation of the sintered structures was measured according to ISO 18675:2022.

Results

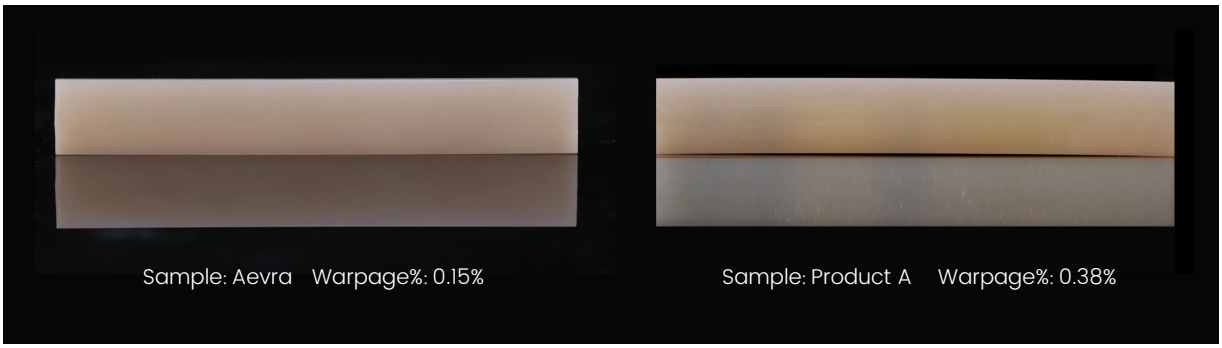


Fig. Warpage between different multilayer zirconia materials

Source: Internal Study, Sinocera-Upcera R&D Department; ISO 18675-2022

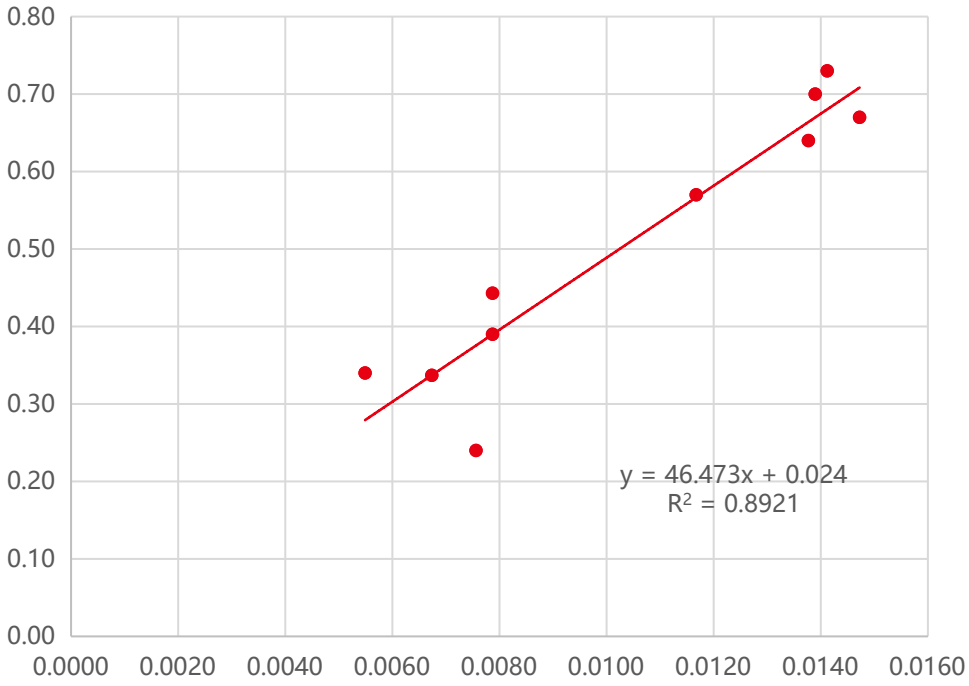


Fig. Fitting analysis of shrinkage and warpage

Conclusion:

Correlation analysis demonstrates a strong positive relationship ($R^2 = 0.90$) between the magnitude of deformation and the theoretical sintering-shrinkage discrepancy across the incisal–cervical gradient, as shown in the figure below. In accordance with ISO 18675:2022, Aevra achieves precise enlargement factors in all three spatial dimensions, ensuring excellent fit even for multi-unit bridge structures. In contrast, Product A exhibits noticeably higher warpage, indicating inferior dimensional stability.

4.4 Polishing Property

It is well established that a properly polished zirconia surface induces minimal wear on steatite antagonists. Therefore, polishing of occlusal contact areas is recommended to prevent antagonist damage in cases where the glaze layer becomes abraded during clinical function. Polishing is also advised when ceramic restorations undergo additional milling or adjustment, as unpolished grinding grooves may act as stress concentrators and initiate microcrack propagation. As an alternative to glazing, full-surface polishing of zirconia can be performed to achieve a smooth, clinically acceptable finish.

Materials and methods:

For each product, three specimens were fabricated with a thickness of 1.00 mm ± 0.02 mm. All specimens were polished using diamond abrasives with a particle size of 15–20 µm on a polishing machine, applying a standardized polishing time of 30 seconds. Surface roughness (Ra) was subsequently measured using a profilometer to evaluate the effectiveness of the polishing procedure.

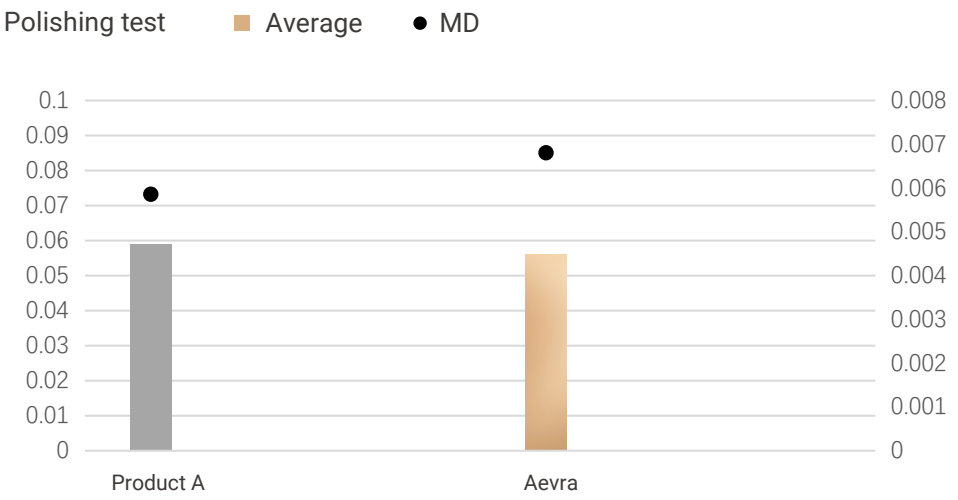


Fig: Polishing performance

Source: Internal Study, Sinocera-Upcera R&D Department

Conclusion:

The test shows that the average roughness of Aevra after polishing is 0.056 μ m, and that of Product A is 0.059 μm. Both of them meet the requirements of high finish surface (Ra < 0.1 μm), and have excellent polishing performance, which can meet the clinical aesthetic and functional requirements.

05 Literature

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