Biomechanics and technical development of implant supported all-ceramic prostheses on Cr-Co-bars

Ceramic pastes for zirconium oxide (Y-TZP) : One-block-technique, part 1

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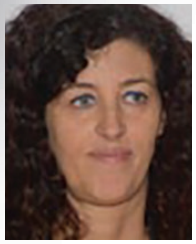

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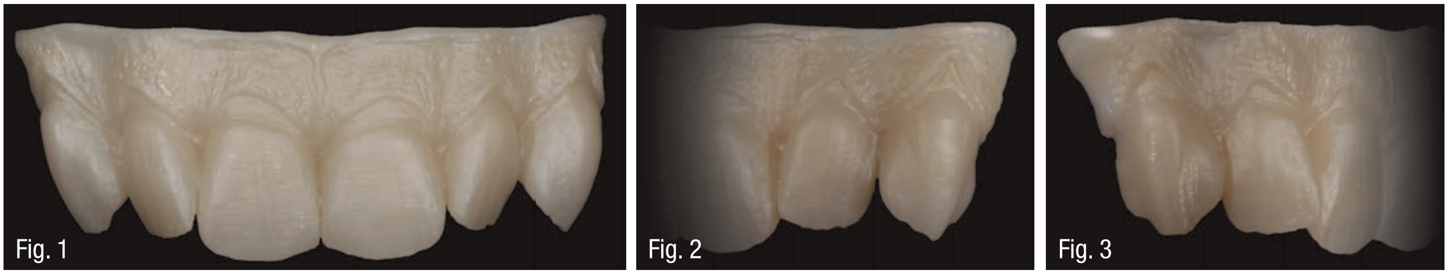
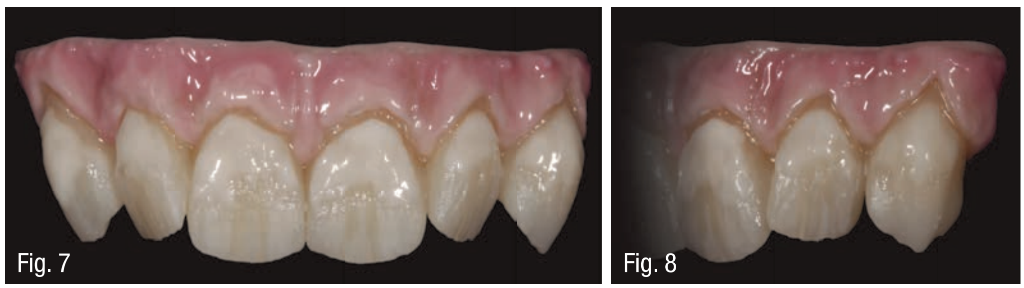
Introducing new industrial techniques that digitized some working steps and had a great impact on implant-prosthetic procedures. These changes also affect the prosthodontic terminology. Often a "revolution", describes digitization of working processes and aims to replace manual techniques based on technical artistic skills with industrial mass production processes.



Figs. 1 to 3 — Structure only one block made of zirconium oxide multilayer.

Figs. 4 to 6 — Applying the 2-d and 3-D ceramic pastes (gingiva). The restoration after firing.

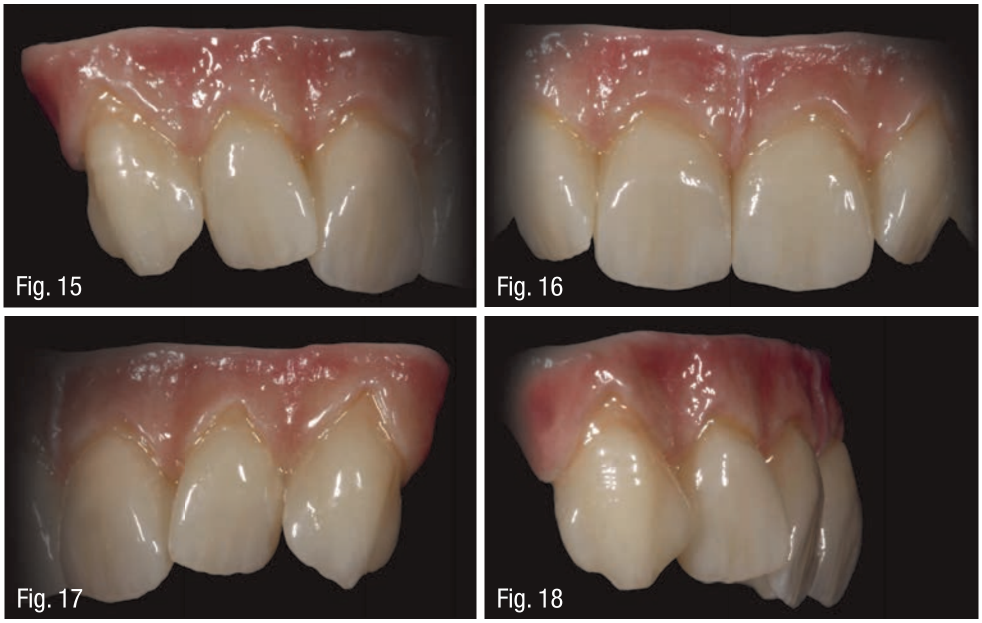
Ahfter many years of research, it was possible to develop ceramic paste materials that can be used to apply two- and three dimensional finishings on monolithic structures: The 2-D pastes for the paint technique, the 3-D pastes for a minimal layering



Figs. 7 & 8 — CeraMotion one touch 3-D gingiva material and 3-D dentine compounds.

Figs. 9 to 11 — CeraMotion one touch 3-D dentine material after firing with different chromatic effects.

Figs. 12 to 14 — Applying different ceraMotion one touch 3-D pastes.



Figs. 15 to 18 — Monolithic zirconium oxide restoration after applying ceraMotion one touch.

of incisal materials as well as dentine and gingiva compounds (fig. 1 to 18). In conclusion, it was finally possible to develop ready-to-use premixed ceramic pastes for the finishing of anatomical restorations made of zirconium oxide and lithium disilicate.

A complex and precise design and fabrication process

The ceramic pastes are made with glass frits which are obtained by melting a mixture of different ceramic oxides at 1500 °C (fig. 19). Applying high-technologic methods, such as thermo-colouration and grinding of the glass frits using air jet technology, produces

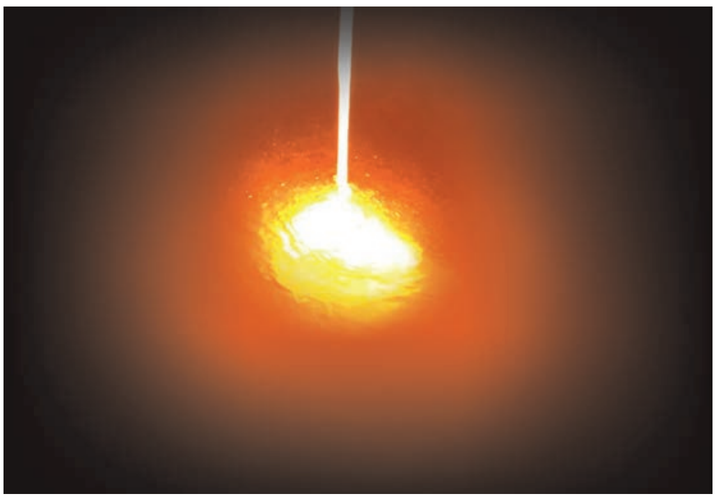


Fig. 19 — Glass melting at 1500 °C.

Fig. 20 — Opalescent glass.

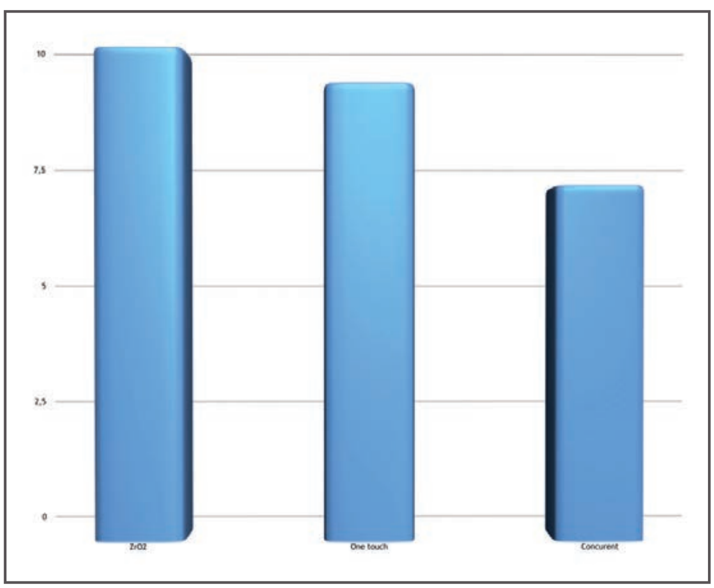


Fig. 21 — Expansion coefficient of the ceramic paste lies slightly under the one of zirconium oxide.

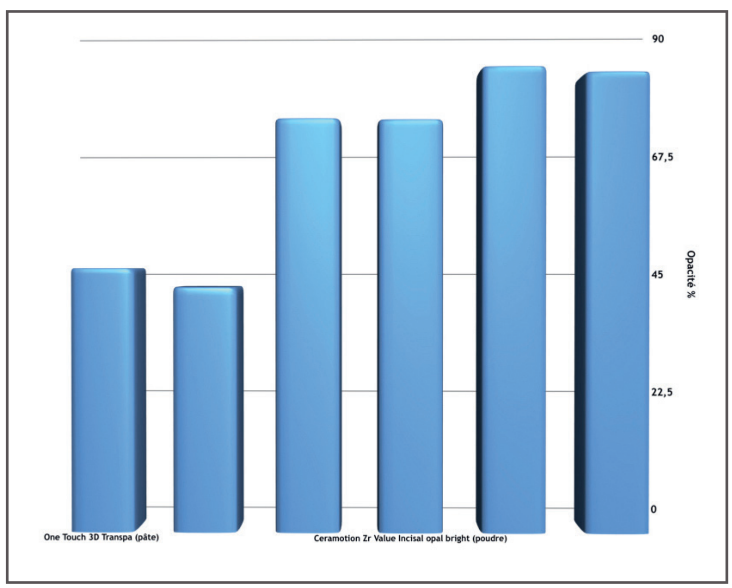
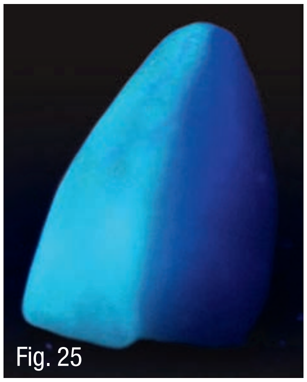


Fig. 22 — Comparing opacity levels between ready-to-use ceramic pastes and common ceramic powders used in the layering technique.

Fig. 23 — Right crown with tinted paste ceramic using thermo-colouration after multiple firings. Left crown with paste paint individualized. Colour agents based on metal oxides cause a combustion process during multiple firings, displaying small black dots caused by oxidation of the existing pigments.



Figs. 24 & 25 — Displaying the fluorescence of ceramic pastes.

Fig. 26 — Gingiva ceramic pastes do not contain fluorescence since in nature the gingiva is not fluorescent.

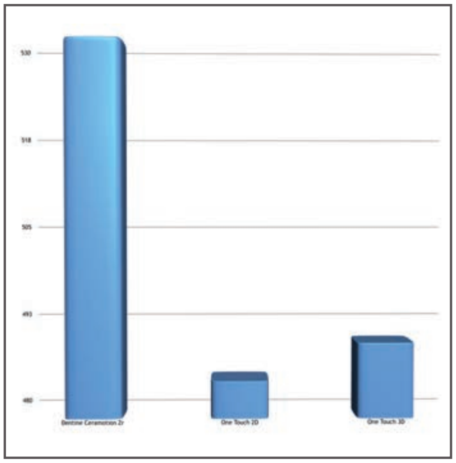


Fig. 27 — Glass transition temperature in C.

the finished product. The created glass compositions, such as nature-opal (fig. 20), are always of the same consistent high quality thanks to a precise and strictly followed fabrication protocol.

The importance of expansion coefficients

Before analysing the properties of a ceramic, we should look at its thermal expansion which is an important parameter in ensuring a secure adhesive bond. The currently available various zirconium oxides and lithium disilicates display, for the most part, heat expansion coefficients between 9.7 and 10.25 (10-6° C-1 bis 500° C).

The fire-bonded ceramic should be slightly under tensile stress exhibiting a lower heat expansion coefficient than the one of the structure material (fig. 21).

However, it should not be too low in order to prevent unnecessary tension in the material. An important specification for paste ceramics is the presence of different opacity similar to the opacity in layering ceramics (fig. 22). With the applied thermo-colouration technique,

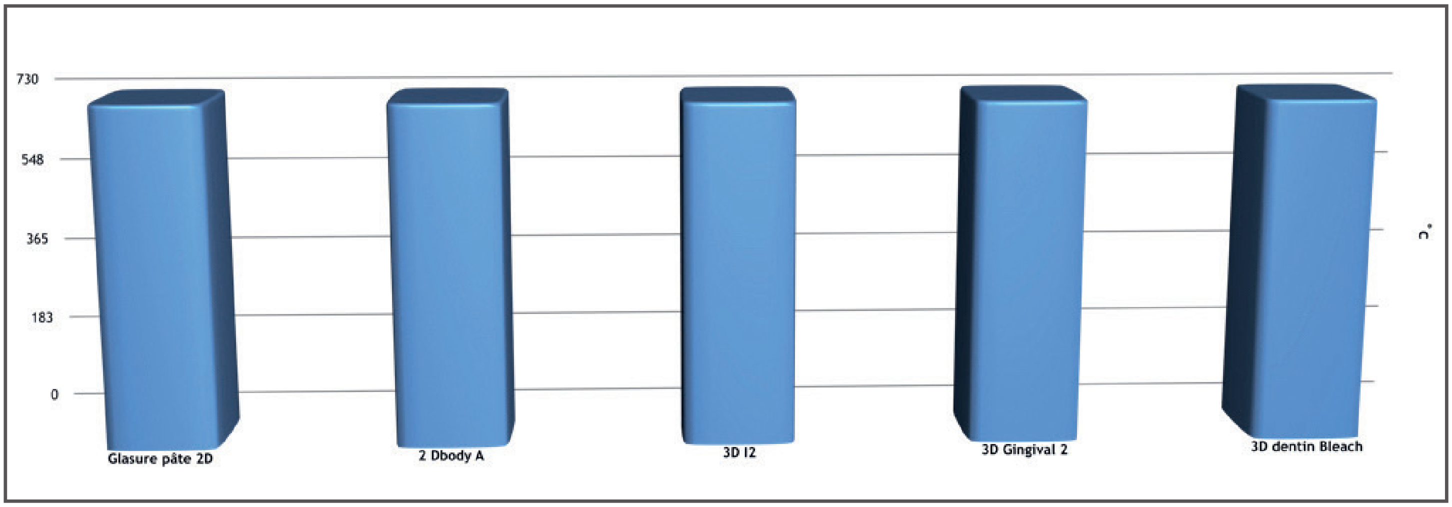


Fig. 28 — Firing temperature of different 2-D and 3-D ceramic pastes in C.

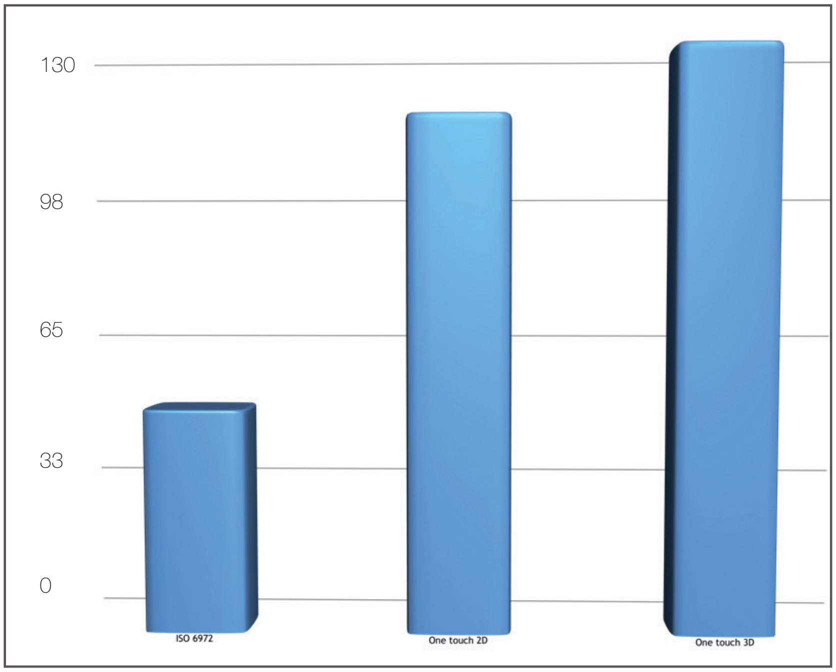


Fig. 29 — The 3-point flexural strength test according to ISO 687 in Mpa.

the pigments are embedded in the glass matrix of the frits preventing pigment oxidation and, therefore, achieving a superior esthetic result. While other fabrication methods can cause a noticeable oxidation of the pigments after multiple firings (fig. 23), Zirconium oxide does not possess natural fluorescence. Applying a thin layer of the ceramic pastes counterbalances this disadvantage, provided the manufacturer adjusted the fluorescence properties so that it looks natural (fig. 24 and 25). An application of at least one-layer fluorescent glazing material with fluorescent dentine gives the crown a natural-looking fluorescent effect. 3-D gingival pastes, on the other hand, do not display fluorescence since natural gingiva does not contain it either (fig. 26).

Guaranteeing long-lasting reliability

In order to achieve a good and reliable ceramic-ceramic bond, "glass materials" must be developed that exhibit an adequate low-glass transition temperature so that they can easily melt onto the ceramic structure. With a Tg (glass transition temperature) between 480 and 490°C, ceramic pastes have a temperature approximately 40°C lower Tg than a common ceramic powder which facilitates working at low temperatures (710 to 730 ° C) and ensures the perfect melting of the material on the structure (fig. 27) creating excellent adhesive bonding with high bonding properties with regard to the requirements of the ISO standard 96938: For 2-D ceramic pastes, the achieved result is 55 MPa; according to international standards, 20 MPa are required.

To facilitate mixing the different ceramic pastes Tg and firing temperatures of the 2-D and 3-D pastes were adapted to each other which offers the advantage that any desired quantities of 2-D and 3-D pastes can be mixed with each other without having to change the firing temperature (fig. 28). The three-point flexural strength of the material is more than twice as high (115 to 130 MPa) as the 50 MPa required by international standards. This results in superior strength of the structure and ceramic veneering (fig. 29). Sd

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