Press for success using an extraordinary combination of strength and aesthetics

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Introduction

The aim of an all-ceramic rehabilitation is to achieve a functional, aesthetically pleasing, long-lasting restoration. There are many criteria which determine the route chosen (patient-specific parameters, preparation, material, fixture, etc.), but these should not affect the defined objective. It is therefore essential that technicians respond flexibly to situations and select the "perfect" material and the optimal manufacturing process on an individual basis. For us, the option to work in the digital workflow is a strong argument for a material.

Many materials and different production technologies exist for manufacturing all-ceramic restorations, which all have their benefits and must be selected by the technician on a case-by-case basis.

1. A "keyboard" of pressable ceramics

Which ceramic is best suited to which indication? At this point, it's worth taking a look at the wider ceramics family. A statement by the DGZMK (The German Society of Oral and Maxillofacial Surgery) divides pressable ceramics into:

1. Material composition: oxide ceramics, silicate ceramics
2. Manufacturing process: integral shape, casting, hot pressing, copy grinding, CAD/CAM
3. Clinical application: conventional cementation, fixed using adhesive

1.1 Differentiation by material composition

Silicate ceramics (e.g. feldspar and glass ceramics) are ideal for restorations on individual teeth (veneers, inlays, onlays) because they behave similarly to enamel. With values of between 50 to 200 MPa, it has low bending strength. In the jaw area, which is under a lot of functional strain, or in multi-faceted restorations, oxide ceramics are preferable (e.g. zirconium oxide). They have a low proportion of glass, resulting in high resistance (bending strength of conventional zirconium oxide of 1000 to 1200 MPa). The limited light-optical properties are balanced out to some degree using a veneer or translucent zirconium oxide (3rd generation). ("Cave: There is a correlation between translucency and strength. The higher the translucency of zirconium oxide, the lower its bending strength). Lithium disilicate has also been established as an equivalent. The strong glass ceramic has a high crystalline proportion of lithium disilicate and lithium orthophosphate. Thanks to improved light-optical properties, the material is also well-suited to, and safe for, monolithic treatments. Conventional lithium disilicate (IPS e.max) has an average final strength of around 360 MPa. We are now hearing discussions that this is just the "lower" measured bending strength and that the actual value is higher. However, in this area we practicians are initially guided by the comprehensive studies from the past few years, in which the researchers always assumed 360 MPa.

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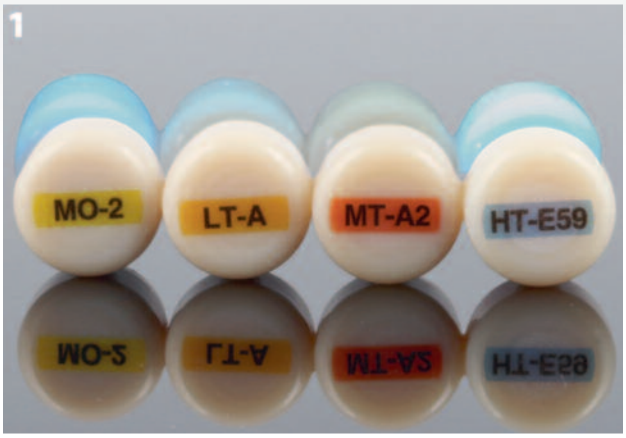


Figure 1: Overview of the four different translucency levels of GC Initial LiSi Press with fluorescing properties

Figure 2: LiSi Press after pressing: the non-existent or very thin reaction layer simplifies removal from the mould and blasting.

1.2 Differentiation by manufacturing process

CAD/CAM (grinding, milling) and pressing should be mentioned as manufacturing technologies for pressable ceramic restorations. The choice of manufacturing method generally depends on the material. For example, oxide ceramics are now used using CAD/CAM technology. Press technology (lost wax technique) is a popular process for glass ceramics and lithium disilicate. A hybrid technology is also often used, in which wax objects are milled by machine and then pressed in the classic fashion.

We prefer this method in our day-to-day work when lithium disilicate is used. With the hybrid technology, we can make maximum use of the benefits of the digital workflow and minimise faulty steps in the manual technology.

Examples from everyday use in the laboratory - material and manufacturing technology

- Hybrid ceramic (e.g. Cerasmart): grinding
- Lithium disilicate (e.g. IPS e.max, GC Initial LiSi Press): pressing, grinding (e.max)
- Oxide ceramic (e.g. Zirlux zirconium oxide): milling
- Veneering ceramic (e.g. GC Initial): manually

→ The press technology is highly relevant when manufacturing pressable ceramic restorations and is an essential component of day-to-day life in our laboratory.

1.3 Differentiation by clinical application

The decision on the type of clinical fixture for a pressable ceramic restoration is based on the material's bending strength. Ceramics with a bending strength of under 350 MPa are fixed using adhesive. For ceramics with a bending strength of more than 350 MPa, there is a choice between conventional, self-adhesive or adhesive fixture.

The criteria mentioned demonstrate the wealth of ceramic materials that a dental laboratory has to work with. To be able to cover everything, it is hardly enough to have only

Figure 3: With around 450 MPa, this provides a high degree of safety for monolithic restorations in the posterior region.

Figure 4: Higher resistance also provides a safe basis for a partially reduced veneer (Initial LiSi).

Figure 5: Optimal interface to GC Initial LiSi. This veneering ceramic has been manufactured exclusively for lithium disilicate structures.

Figure 6: The initial situation poses a major challenge for us as the team responsible for treatment.

Figure 7: Insufficient restorations in the upper posterior region and tooth structure damage in the front tooth area.

one pressable ceramic system. This is why a carefully thought-through ‘keyboard’ of pressable ceramics is used in our laboratory. The transitions are often fluid and sometimes “blurry”, but we need different pressable ceramic materials nonetheless. With a graded range, we make individual aesthetically pleasing and clinically long-lasting restorations for each patient, without losing sight of the need for efficiency in everyday life in the laboratory.

2. Press technology as a building block for success

One “key” on our pressable ceramic keyboard is press technology and we gratefully profit from its advantages. These include the 1:1 transposition of wax modelling into ceramic, the efficient process, the high quality of the material and the good aesthetic results. Because there is often no need for conventional stratification, this reduces the amount of work required, the sources of errors and the factors which can affect the material’s structure. For us, the indication “monolithic” is a decisive argument for a material. In our laboratory, monolithic restoration in the posterior region has been established as a firm standard. An overview of the benefits of press technology:

- Loss-free transfer of wax modelling to ceramic,
- Aesthetic benefits,
- Precise moulding of edge regions,
- Microscopically exact ceramic layers,
- No sinter shrinkage.

The success of press technology can be traced back to the innovative material lithium disilicate - high-strength glass ceramic.

When deciding on a new lithium disilicate, we set the bar high and take our lead from the classic IPS e.max Ivoclar Vivadent (Schaan, Liechtenstein). The newcomer GC Initial LiSi Press is generating a beneficial impetus for this standard.

IPS e.max Press set a bar that is still viewed as the standard across the board today. This relates to both the aesthetic qualities and the physical properties. We have also come to recognise the benefits of lithium disilicate and won’t accept limitations in a new product where it is concerned.

We’ve been spoilt by the good light-optical properties, the wide range of colours and translucency, and the high strength for a glass ceramic. Today, we are no longer able to do without these features. Based on the existing standards, there has been an impressive process of development over the past few years in which other manufacturers were also involved, e.g. GC (GC Europe, Leuven). Now, with GC Initial LiSi Press, there is another lithium disilicate available for pressing which combines the aforementioned advantages and develops them further.

3. GC Initial LiSi Press

GC LiSi Press has succeeded in optimising the physical properties and material qualities. Furthermore, the colour saturation has been amended. On the one hand, the fluorescent effect is well-balanced and natural. On the other, the levels of value and chroma are ideal and this can be seen in the higher colour density. The opportunities that GC Lustre Pastes and GC Initial LiSi veneering ceramic offer are also impressive. We can work within a rounded product portfolio which opens up excellent opportunities.

- Optimised material qualities,
- Improved light-optical properties (colour density),
- Simplified manufacturing process,
- Ideal equivalent: LiSi veneering ceramic, Lustre Pastes.

3.1 Optimised material qualities

Essentially, the physical properties of a ceramic are influenced by the composition of the raw materials and the added materials, as well as the manufacturing process. Among other things, the grain size determines the quality of the material. GC Initial LiSi Press has a refined grain. The

Figure 8 and 9: The prepared posterior teeth prior to impression.

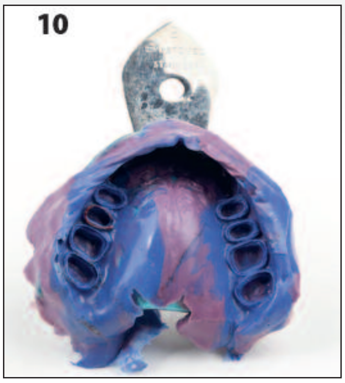


Figure 10: The situation was cleanly moulded using polyether impression-making material.

Figure 11: The wax models sprued on the ring base with the front tooth crowns as an example.

High Density Micronization (HDM) technology was developed specially for the manufacture of this lithium disilicate. This results in evenly dispersed lithium disilicate microcrystals which fill the entire glass matrix. (→Cave: if the crystals are larger, the matrix structure cannot be fully exploited.) The small grains are the basis for LiSi Press's good material properties. From our perspective as practicians, it makes complete sense to continue developing the basic substance. The smaller the grain, the less the glass matrix is open to attack, through etching, for example, and the greater the apparent resistance to ageing. For single tooth crowns on implants, for example, this increases our confidence in the long-term stability. The individual small grain also helps to ensure effective polishing. The residual roughness is considerably reduced. The surfaces are extremely smooth and homogeneous. It should also be noted that the refined grains also ensure lower abrasion values and greater age-resistance.

3.2 Improved light-optical properties

HDM technology also seems to have a positive impact on the aesthetic qualities. LiSi Press is divided into four levels of translucency, the nomenclature of which takes its lead from IPS e.max. As technicians, therefore, we don't have to learn any new terminology but can work with the different translucency levels as usual: HT (= highly translucent, high translucency), MT (= medium translucent, medium translucency), LT (= low translucent, low translucency), MO (= medium opaque, barely translucent) (Fig. 1).

The colour density is adapted to the natural tooth substance. The fluorescing qualities and the optimised value guarantee aesthetically pleasing results, with barely any difference from the natural tooth. It is even possible to perform monolithic restorations in the posterior region without noticeable aesthetic issues. With monolithic application, we have previously been able to achieve impressively natural-looking results.

3.3 Simplified manufacturing process

We distinguish between the pressing of manually modelled objects and the pressing of milled wax structures. The actual pressing process is similar to the usual process in essence. What makes LiSi Press's manufacturing process unique is the thin reaction layer (Fig. 2). There is no need for "etching" acidification in hydrofluoric acid after removal from the mould. This is another convincing argument for the new pressable ceramic. We would ideally like to remove an application as sensitive and critical as acidification from our laboratory. This makes the procedure and the working processes within the laboratory considerably safer. The extremely thin reaction layer after pressing is based on the investment LiSi Press Vest, a new development from GC. The manufacturer is highly skilled in the area of investment materials and in this case, they concentrated on the time-consuming reaction layer after pressing. The problem was solved with a special formula. There is barely any reaction layer present, making the process of removal from the mould considerably simpler. The pressed object is just blasted with glass beads. After this, the technician focuses directly on refining the restoration. In our experience, 15 to 20 minutes can be saved for each unit.

3.4 Veneering technology

GC Initial Lustre Pastes NF are used to refine monolithic restorations (Fig. 3). The three-dimensional ceramic stains encourage high colour depth and ensure vibrant translucency. Where aesthetics are concerned, we like to work partially monolithically and veneer the visible portions with GC Initial LiSi (Fig. 4). This veneering ceramic includes a colour and layer system (Fig. 5) which distinguishes itself through an agreed heat extension coefficient, a low firing temperature and high stability. It is not complicated to use and can be used in both individual layering, which many technicians like, and in the cutback technique. We prefer partial monolithic veneering and have had very good and stable results with it for many years now. We always design critical areas (palatal, occlusal) fully anatomically. This means that aesthetic aspects and safety are perfectly combined.

GC Initial LiSi Press combines strength and aesthetic aspects. The material can be used for many indications and its shape and colour remain wholly stable, even after multiple firings.

Strength:

- 450 MPa

Indications:

- Tabletops/partial crowns
- Veneers, inlays
- Crowns in the front and posterior region
- Implant crowns

Aesthetics:

- Perfect fluorescence and opalescence

Process:

- Classic press technology (LiSi Press Vent) but with extremely thin reaction layer
- Veneering technology: GC Initial Lustre Pastes NF, GC Initial LiSi veneering ceramic

4. Case report

The patient consulted the practice with a challenging situation in her upper jaw (Fig. 6 and 7). She had insufficient metal ceramic restorations in the posterior region. The front tooth area had a marked lack of hard tooth tissue. After an initial diagnosis and consultation, pressable ceramic rehabilitation was chosen. For us, portrait photography is an important component of diagnosis, as it can be used to collect important information for planning the therapy. In this case, it was important to consider the origins of the tooth damage, which could be traced back to defective functions, to provide a restoration based on gnathological criteria. Because it can be worked perfectly in the posterior area using manual modelling, we opted for press technology. The eight individual crowns were to be constructed first in the CAD software, then milled in wax, finely reworked manually (edge regions, occlusion) and then pressed in ceramic. In the front tooth area, partially anatomically reduced crown frameworks were to be produced and veneered.

4.1 Caring for the posterior teeth

Preparation of the posterior teeth followed a functional pre-treatment (Fig. 8 and 9). The preparation design was based on the known parameters for pressable ceramic restorations. The situation was cleanly moulded using polyether (Fig. 10) and the master model was manufactured in the laboratory.

As the material of choice, we viewed GC Initial LiSi Press as ideally suited. On the one hand, the dentist responsible for treatment is very familiar with the adhesive technology for implantation, which is a decision criterion for pressable ceramic. Functional criteria also played a significant role in the choice of material. Traditional pressable ceramic would be too soft for the relatively high strain of the chewing function. On the other hand, a conventional zirconium oxide would be too hard and, due to its light-optical properties as a monolithic structure, is not well-suited. It is also impossible to manufacture using press technology. This is why translucent zirconium oxide - lower bending strength - was also ruled out. We felt that press technology was the only suitable manufacturing process. It offers the major advantage that anything that we model in wax can be transferred to ceramic 1:1. The CAD/CAM wax crowns can be adapted precisely to the occlusal particularities using the articulator. It was in precisely this situation that taking into account the gnathological situation was a success for determining parameters.

Symbiosis: Classic tool and digital workflow

CAD/CAM manufacture of wax crowns was followed by manual adaptation. Essentially, fine modelling requires our gnathological knowledge and manual skills. We use these tried-and-tested dental tools every day, despite CAD/CAM and digital aids. The art lies in being able to interpret and implement the connections between form and function. With a probe and modelling wax, we developed a morphology which follows the biomechanical criteria. All functional surfaces were cleanly modelled, both dynamically and statically. We carefully created cusps, fine bulges, delicate fissures, strips and all the other functional elements inside a tooth in wax. The individual crowns were fixed to the ring base of the muffle using wax wire and a sprue. To guarantee a smooth flow of viscose ceramic during the pressing process, the sprue should be fixed in the direction of flow of the ceramic and at the thickest part of the wax object (Fig. 11).

Figure 12: Spraying the wax surfaces with the SR liquid to refine the surfaces using the example of the front tooth crowns.

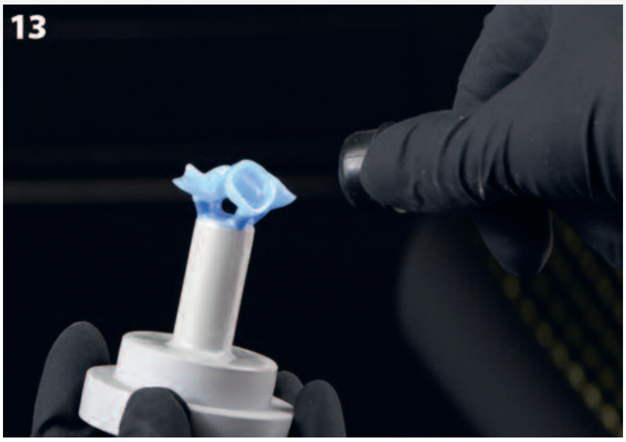


Figure 13: Thorough dispersal of the liquid with pressurised air using the example of the posterior tooth crowns.

Figure 13a-13b: The milling of wax in the CAD / CAM workflow is for us essential (hybrid technology)

Place in mould, press, remove from mould

Investment is carried out using the phosphate-bonded investment GC LiSi PressVest. The wax surfaces are sprayed with the SR liquid in advance and any surplus is thoroughly dispersed (Fig. 12 and 13). SR liquid contains a high concentration of a surface-refining solution. This ensures that the reaction layer, which is minimal in any case, is easy to remove. The muffle could now be filled with the investment material, mixed according to the manufacturer's instructions. GC LiSi Press Vest has excellent flow capabilities (Fig. 14) but precise investment is essential for loss-free transfer of the modelling. In line with the instructions, the muffles were preheated (850 °C) and the pressing process was started once the pellet (Fig. 15) had been selected. (→Cave: We recommend the single-use pressing stamp. Quick cooling after the pressing process should be avoided.)

After it had cooled, the muffle was cut into segments with a cutting disc. When doing so, one must ensure that it has cooled sufficiently. Next, the minimal reaction layer on the pressed objects was blasted with glass beads (pressure: 4 bars and then 2 bars).

→Cave: Aluminium oxide must not be used for removal from the mould. Hydrofluoric acid is not required.

Finishing

The objects were finished with small ceramically-bound stones anddiamonds (Fig. 16 and 17). The rotating tools should be used at low rotational speeds, for cooling and with low pressure. One should avoid overheating the ceramic. After a pre-polish with rubber polishers (Fig. 18),

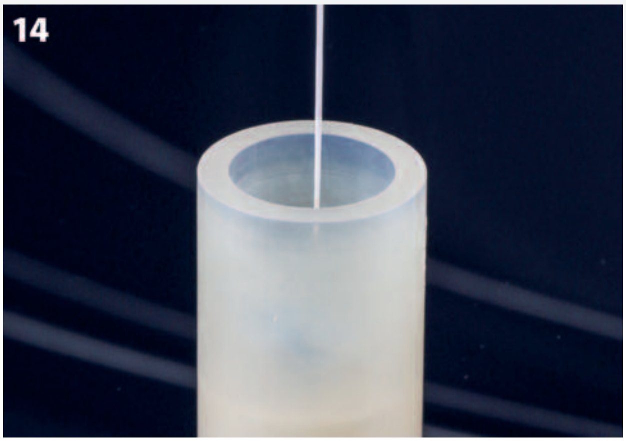


Figure 14: The investment material GC LiSi Press Vest is characterised by particularly good flow capability.

Figure 15: The different colours and translucencies of the lithium disilicate GC Initial LiSi Press.

Figure 16: Finishing the surfaces with small ceramically-bound stones.

Figure 17: Finishing with diamantes. It should be ensured that it has cooled sufficiently.

Figure 18: Pre-polish with coordinated special rubber polishers.

Lustre Pastes and glazing were used for colouring.

Next, the monolithic restorations were checked on the model (Fig. 19 and 20) and cemented in the mouth in the practice using adhesive (G-CEM LinkForce, GC) (Fig. 21).

4.2 Caring for the front teeth

Rehabilitation in the front tooth area had a high degree of difficulty (Fig. 22). The first requirement for a smooth red-white procedure was a surgical crown extension. The dentist used a deep-drawing template of the set-up as orientation for the aesthetic sequence of the crown edges (Fig. 23 to 27). During the healing phase, CAD CAM-manufactured long-lasting temporary solutions helped to shape the ginigiva (Fig. 28).

Eight months later, an impression was taken of the situation (Fig. 29).

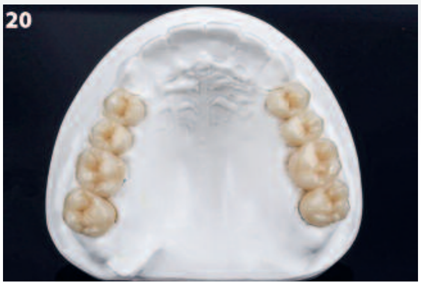
Producing the crown structures

The master model was digitalised and the STL data were imported into the construction software (3Shape). The set-up (Fig. 30) could be milled in wax in accordance with the planning documents (Fig. 31) and could then be transferred into GC Initial LiSi Press. After the quick process of removal from the mould, the LiSi Press crowns fitted very well on the master model (Fig. 32).

Veneering

To refine the front tooth crowns, the proportion of enamel was carefully reduced (cutback) (Fig. 33). To achieve good colour depth and vibrant translucency, we first applied GC Lustre Pastes (ceramic stains).

As a next step, the crowns were completed with incisal and effect materials (GC Initial LiSi) and fired (Fig. 35 and 36). (→Cave: The LiSi restorations should not be heated or

Figures 19 and 20: Checking the monolithic posterior crowns on the model.

Figure 21: The situation post-adhesive cementation of pressable ceramic monolithic posterior tooth crowns.

Figure 22: Challenge: rehabilitation in the upper front tooth area.

Figure 23: A rail template visualised the ideal crown sequence in the cervical area.

Figures 24 and 25: Surgical crown extension and pre-preparation of the teeth for fitting of the long-lasting temporary solution.

Figures 24 and 25: Surgical crown extension and pre-preparation of the teeth for fitting of the long-lasting temporary solution.


Figures 26 and 27: Immediately after the surgical crown extension (left) and the situation after a few weeks (right).

Figure 28: Post-operative situation with long-lasting temporary solution after eight weeks.

cooled too quickly. Quick temperature changes can cause the material to tear. During firing, a suitable firing tray - e.g. a honeycomb tray - as well as retaining bolts and fluid firing pads should be used.)

Finishing

Even after just a few steps, the aesthetic restoration was almost finished (Fig. 37 and 38). The incisal edges were prepared and the surface texture created with purpose-made special rubber polishers (Fig. 39 and 40). The polishing was designed simply (Reminder: small grain size)

Figure 29: Eight months later: Preparation for impression-making.

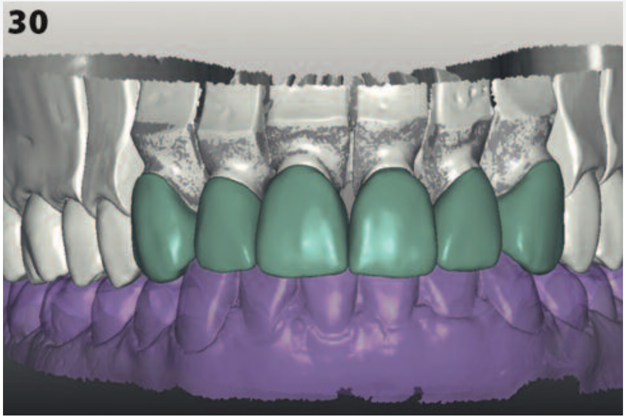


Figure 30: Crowns constructed in the software for milling the wax caps.

Figure 31: The milled wax caps were....

Figure 32: ...transferred into LiSi Press using press technology..

Figure 33: Cutback in the enamel area as preparation for thin film veneering. GC Lustre Pastes are then applied.

Figure 35: Finishing of the crowns with incisal and effect materials (GC Initial LiSi).

Figure 36: Firing on suitable honeycomb firing trays, matching retaining bolts and fluid firing pads.

Figures 37- 40 The structures, refined with thin-layer veneering, are finished in shape and morphology after firing (above) using specially designed rubber polishers.

Figure 41: Situation immediately after adhesive cementation of the crowns.

Figure 42: Harmonious view of the lips. Shape and colour adapt extremely well.

Figures 43 and 44 Before/after juxtaposition. The patient was treated with individual pressable ceramic crowns in the upper front tooth and posterior region, after a functional pre-treatment and a surgical crown extension.

so as to achieve a smooth, homogeneous surface quickly. After the restorations were checked on the model and in the mouth, the crowns were finally cemented (G-CEM LinkForce, GC) (Fig. 41 to 44). The light-optical properties of the front tooth crowns were impressive. A touch of veneering ceramic enabled us to achieve a vibrant internal play of colours.

5. Conclusion

To be able to cover all indications for pressable ceramic restorations, we require different groups of materials (oxide ceramics, hybrid ceramics and lithium disilicate) depending on the indication. The manufacturing technique varies accordingly (cf. point 1.2). As a hybrid process, press technology has been a regular feature of everyday work in our laboratory for several years. Now that we have achieved excellent results with lithium disilicate for a long time, we see in GC Initial LiSi Press a logical development and aesthetic improvements. The four benefits that are important to us are increased bending flexibility (450 MPa), increased light-optical properties (colour density), the simplified manufacturing process (minimal reaction layer) and the ideal counterpart to GC Initial veneering system (GC Initial LiSi), as well as the excellent Lustre Pastes stains. Working within a system offers us a high degree of certainty that we will find the right material for the indication in question.

Acknowledgements

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