



Inside Out





## A Technique for Faster and More Predictable Layering

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Technology has emerged in our profession in an irreversible and positive way. The digitalization of our laboratories has brought greater productivity while democratizing ceramic restoration—meaning that the average laboratory, thanks to this technology, has managed to scale its product and more easily maintain greater regularity in quality.

Facing this reality, the dental technician often asks: Does ceramic layering have a future? Will it resist the monolithic restoration? The answer is not simple, but we are still far from having a monolithic material that provides the same esthetic quality as a good layering.

This article demonstrates a simple protocol that will give technicians the ability to benefit from digitalization (increase production and maintain consistent quality) in ceramic layering as well.



1a



1b



2a



2b



2c

**Figs 1a and 1b** Before and after photographs of clinical case (Dr Oriol Llana) demonstrate dentin layering with little prominence of enamel.

**Figs 2a to 2c** Before and after photographs of clinical case (Dr Jon Gurrea) demonstrate layering with prominence of enamel.

## INCISAL EDGE POSITION

The diagnostic wax-up provides a great deal of information about a restoration:

- Emergence profile
- Volume
- Shape
- Length
- Amplitude
- Incisal edge position

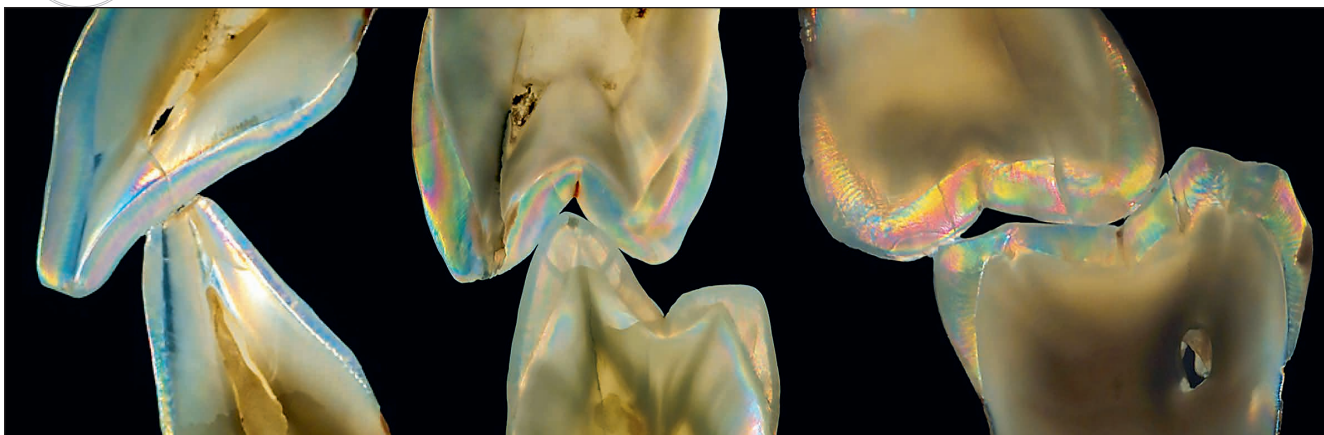
A good layering with that information should guarantee success. However, while many authors have developed protocols to guide the ceramist in copying the diagnostic wax-up, unfortunately the results obtained are usually somewhat approximate.

Without a doubt, the incisal edge position is the most important information provided by the wax-up. The location of the incisal edge will be decisive for the success of layering. Consider the before-and-after images of the two clinical cases shown in Figs 1 and 2. If asked what we like best about the definitive restorations (Figs 1b and 2b), each of us will focus on something different—some on the layer-

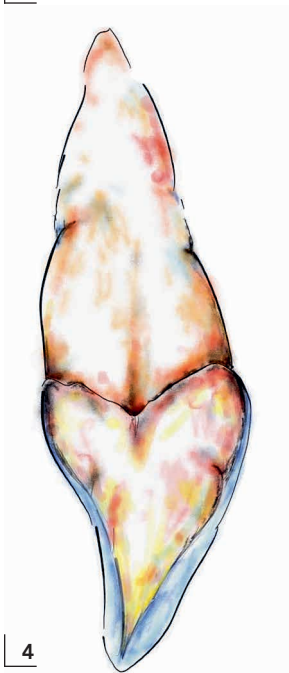
ing, others on the mamelons. In the end, we will have a set of details that together provide a well-balanced, successful result.

Consider next a natural tooth, which is basically formed of two structures—the internal dentin and the enamel. A sagittal cut illustrates these two layers and the intimate relationship between them (Fig 3). In any such example it is apparent that the proportion of enamel and dentin is not symmetric, and that the dentinal structure loses volume as it is projected to the incisal edge, the enamel being the main protagonist. For this reason, it is important to locate the position of the incisal edge in space when layering, since all the internal layers must be projected toward that point. The success of any layering, whether simple or complex, is based on the balance between internal and external masses (Fig 4).

Technicians frequently use palatal silicone keys to maintain the incisal position throughout the layering process. With these keys, the position of the dentin is 100% guaranteed (Fig 5). Once the dentins are added, we must continue applying masses beyond the incisal edge to compensate for the vertical contraction of the ceramic. To do so requires removing the silicone key, so the remainder of the layering will be done without any reference (Fig 6). This



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**Fig 3** The amounts of dentin and enamel are not symmetric in the natural tooth.

**Fig 4** Layered internal masses must project toward the incisal edge to achieve balance between internal and external masses.

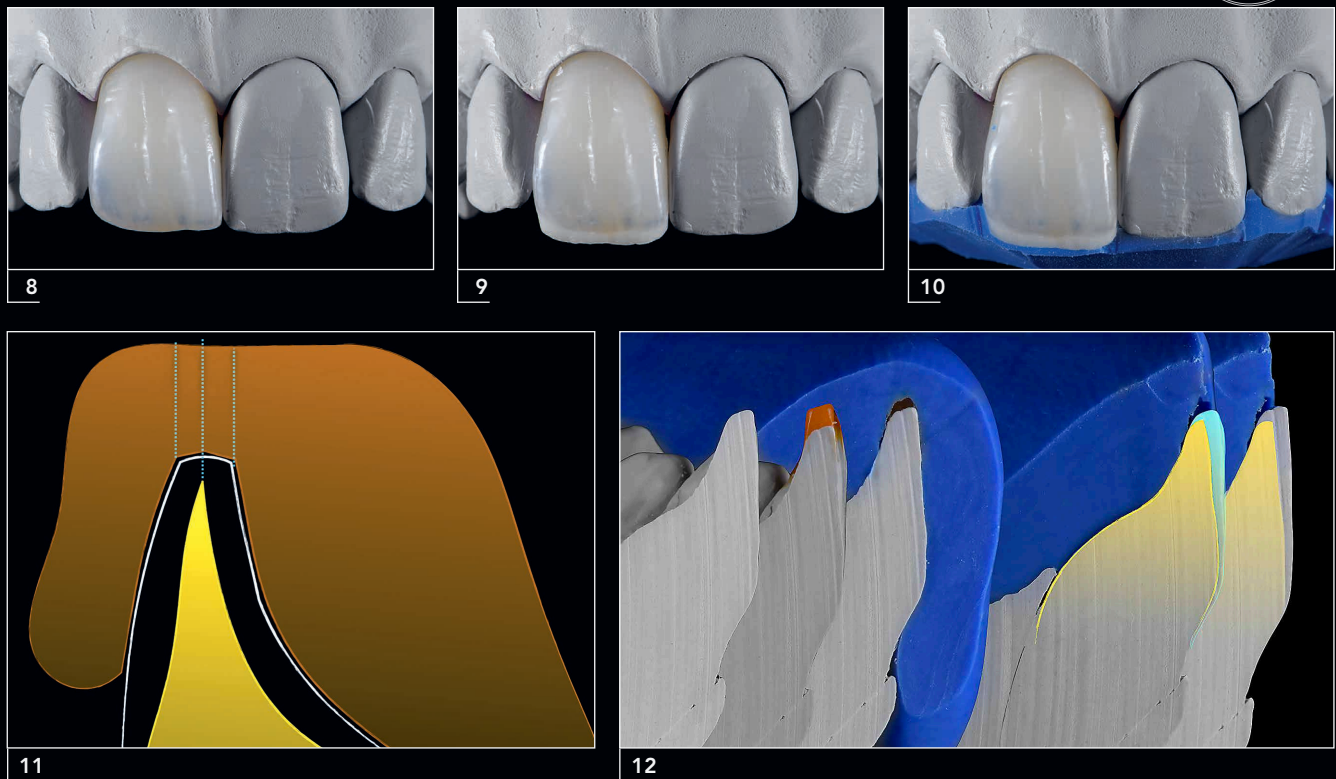
**Fig 5** With a silicone key it is easy to place the internal masses.

**Fig 6** Extending a restoration to compensate for the vertical contraction of the ceramic must be done without the silicone reference.

**Fig 7** If the silicone key can remain in place when layering, the result will be a good balance of color and quicker restoration.

is not a problem if a restoration requires only two crowns, since the remaining teeth provide many references to control the correct position of the internal masses. But the references are lost in a larger rehabilitation, such as six anterior units, and it is easy to lingualize or vestibularize

these masses. If all the layering is done with the silicone key as a guide, there will be a good color result but the crown in this case will be approximately 1.5 mm short of the desired length (Fig 7).



**Fig 8** The diagnostic wax-up indicates the future incisal position.

**Fig 9** Vertical contraction of the ceramics is compensated for by adding wax. In this case, 1.5 mm is added.

**Fig 10** A silicone key is made for use as a support throughout the layering.

**Fig 11** Three cutting options for the silicone key incisal edge: (A) vestibular, (B) center, and (C) palatal.

**Fig 12** Two silicone keys, the enamel (A) and dentin (B), are removed.

## THE INSIDE OUT CONCEPT

The Inside Out concept uses silicone keys that compensate for the vertical contraction of the ceramic and can remain in place to guide the layering process. For this, the amount of contraction of the ceramic being used must be known or can be approximated by measuring a crown before and after baking. In the case illustrated, using IPS e.max (Ivoclar Vivadent), the contraction will be approximately 1.5 mm.

Starting from a diagnostic wax-up (Fig 8), the vertical contraction is compensated for by lengthening the incisal contour 1.5 mm with wax (Fig 9) and then making a silicone key that will register this new incisal position (Fig 10).

The next step is to cut the silicone key. There are three cutting options at the incisal edge, as shown in Fig 11: (A) the vestibular aspect; (B) the center of the incisal edge, where the dentin is projected; and (C) the palatal aspect. Think of a simple layering of two masses using two, instead of one, silicone keys—one cut in the vestibular as-

pect (A, which we will call enamel key) and another cut in the center of the incisal edge (B, which we will call dentin key). First the dentin key (B) is filled with the internal masses, then it is changed to the enamel key (A) and filled with the incisal (Fig 12).

For a complex layering, the procedure would be the same except that on the dentin key (B) all the internal masses are placed (as shown in Figs 13 to 15), resulting in an extremely simple and fast exercise. The dentin key is replaced by the enamel key (A), where the space for the external masses is generated (Figs 16a and 16b). The next step is simply to fill the silicone with the incisors chosen.

After the bake, the incisal position of the restoration is the same as in the diagnostic wax-up (Figs 17a and 17b). Note the balance between dentin and enamel, thanks to the guided layering. Finishing of the restoration can then be accomplished and the restoration completed in a shorter amount of time.



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**Fig 13** The dentin silicone key in place.



14a

**Fig 14a** A mixture of e.max Ceram Power Dentin A1 + Oc Dentin Orange 50% is added in the cervical area.



14b

**Fig 14b** Power Dentin A1 pure, a high-value dentin, is placed.



15a

**Fig 15a** In the incisal area, a translucent dentin (DA1 + TN 50%) is placed.



15b

**Fig 15b** The placement of all the effects necessary to build a restoration is quick and easy with the guidance of the silicone keys.



16a

**Figs 16a and 16b** Once the internal layering is completed, the dentin key is replaced by the enamel key to generate the space necessary for the external layer.



16b



17a

**Fig 17a** Final result after bake.



17b

**Fig 17b** The final result after finishing is very predictable.



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**Fig 18** The result obtained by different technicians is surprisingly similar.

**Fig 19** The color is checked using the eLAB technique developed by Sascha Hein and minimal difference is found.

It is interesting to see the results obtained by different technicians using the same model, masses, and silicone keys. As shown in Figs 18 and 19, the results obtained are quite similar. A numerical reading of the color results indicate minimal difference, which demonstrates that using

the Inside Out technique will allow technicians to scale ceramic restorations in their laboratories in a predictable way. Not only does the technique provide predictability, but approximately 30% savings of time.



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**Fig 20** Preoperative view of patient with lateral agenesis. Canines have been moved orthodontically to replace the lateral incisors. (Case by Dr Oscar González.)

**Fig 21** Only the canines will be prepared for the veneer restoration from premolar to premolar.

**Fig 22** Diagnostic wax-up from which the enamel key is obtained.

## MINIMALLY INVASIVE RESTORATIONS WITH INSIDE OUT

Cases requiring very little ceramic layering are now common. But this does not mean they are any less difficult; seeking balance between the interior and the exterior layering is still required. To use the Inside Out technique with minimally invasive restorations, some parameters must be taken into account.

In general, minimally invasive restorations will lack internal dentin, requiring only the completion of some non-existent volume (for example, an incisal contour), increasing the enamel volume and nothing more. The intermediate bake technique can be used for greater control of the transition between the restoration area with support and the area that does not have support. If Inside Out is used for this, in most cases it will not be necessary to work with both silicone keys, or at least as described so far.

Consider the case shown in Fig 20. In this patient with lateral agenesis, the canines were moved orthodontically to replace the lateral incisors. The treatment plan was to restore the teeth with veneers from premolar to premolar with preparation only of the canines to facilitate their transformation into laterals (Fig 21). It was also planned to increase the value of the veneers by a minimum of two shades.

As always, a diagnostic wax-up is the first step. Already knowing that there will not be enough space derived from preparation, space will need to be generated by increasing the volume of the vestibular aspect in order to clarify the patient's dentinal color. In this situation, an intermediate bake is in order. The enamel key will be obtained directly from the diagnostic wax-up and cut, as described previously, on the vestibular aspect of the incisal edge. The objective of this key is to provide the incisal position of the diagnostic wax-up and the final volume of enamel (Fig 22). Once we have this silicone key, the diagnostic wax-up model is copied and 1.5 mm added to compensate for the

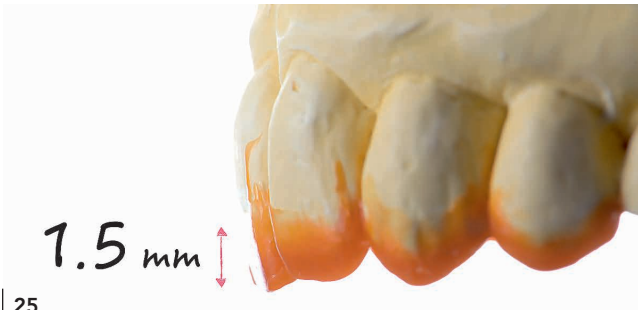




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**Fig 23** Diagnostic wax-up is copied.

**Fig 24** Compensation for contraction is begun.

**Fig 25** Average contraction is 1.5 mm.

**Fig 26** Compensation of the vertical contraction of the ceramic.

**Fig 27** The dentin key is made.

**Fig 28** The center of the incisal edge will be cut.

**Fig 29** Note the space generated for the first bake.

vertical contraction of the ceramic (Figs 23 to 26). Next, as shown in Figs 27 to 29, the dentin key that will support the internal layering is made. With these two silicone keys ready, the ceramic layering can begin.

The silicone key is placed and the entire incisal area is lengthened with dentins and effects (Figs 30 and 31). Once the intermediate bake is done, all the vertical contraction that has been obtained can be seen (Fig 32). When the



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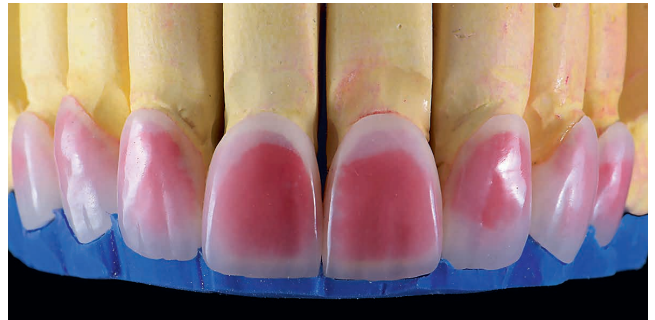
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36a



36b

**Fig 30** Layering of dentins.

**Fig 31** After baking, internal characteristics, including mamelons and bluish triangles, are added.

**Fig 32** After intermediate bake, the vertical contraction is evident.

**Fig 33** Note how this first bake is perfectly located in the diagnostic wax-up.

**Fig 34** Once the enamel is applied, the restorations follow the incisal guide generated in the diagnostic wax-up.

**Fig 35** Veneers recovered following the incisal guide.

**Figs 36a and 36b** The volumetric resemblance of waxing and finished veneers is evident.

dentin key is replaced with the enamel key—remember that it was made using diagnostic wax-up without compensating for the contraction—you can see how everything done internally is perfectly placed (Fig 33). The space gen-

erated by the enamel key is filled and the restoration baked, demonstrating how simply the diagnostic wax-up was replicated (Figs 34 to 39).



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**Fig 37** Ceramic restorations so thin will have little color effect. In this case, the value was increased.

**Figs 38 and 39** Definitive restorations a few weeks after being cemented: veneers 0.2 mm/0.4 mm thick, without preparation and supragingival final cementation.

## CONCLUSION

With Inside Out, all the morphologic information and space position of the incisal edge of a diagnostic wax-up can be transferred to the ceramic restoration regardless of the layering complexity. This technique not only simplifies the ceramic layering, but also provides savings of about 30% of our working time and makes the outcome more predictable.

Inside Out generates a similar effect to digitalization, in that it offers the possibility of increased laboratory productivity and makes the technician's hand less decisive in terms of final quality. Using this technique, differences in results by technicians within the same laboratory decrease, since they are all guided by the same proportions of dentin and enamel. The great difference between the technicians will be in how they place and contrast the ceramic colors.