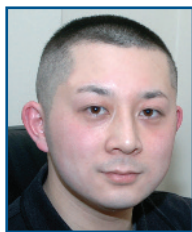


# The final result for colour control on zirconia crowns

By Taishi Kodama, RDT



*“Zirconia has had a major impact on the way in which dental technicians practise their craft, enabling us to meet the aesthetic demands of patients to the greatest extent possible...”*

**N**o longer a rare material in the dental industry, zirconia has become one of the most commonly used materials in aesthetic dentistry in recent years. Advances in CAD/CAM technology have expanded the potential of zirconia immensely and there is now no limit to its possible applications. This next-generation concept offers a truly marvelous approach for those in the dental profession who strive to perfect aesthetic dental restorations that look as much like natural teeth as possible. Although all-ceramic restorations have been an important component in dental treatment for many years, it cannot be denied that, due to ceramic’s inherent brittleness and problems with adhesive cementation, failures, particularly fractures, have been frequent. Today, however, with the development of stronger ceramic materials and major advances in bonding and cementation techniques, based on reliable scientific data, much more satisfactory success rates are being achieved in regular clinical practice. In many ways, zirconia has greatly changed the course of history of this area of dentistry.

Until a few years ago, metal ceramics enjoyed overwhelming popularity in the area of aesthetic restorations. Zirconia’s growing popularity could lead it to be described as the “white metal” of



Figure 1. Examples of zirconia-based restorations completed by the author.



Figure 2. The colours of nature and the moisture that hydrates them – these closely resemble the conditions inside the mouth. We can learn so many things by looking closely at nature. It is important that we devote ourselves every day to that eternal theme of achieving the most natural-looking teeth.



Figure 3. The degree to which the restoration blends in with the surrounding dentition inside the mouth is in direct proportion to the amount of information the dental technician is able to obtain prior to the procedure.

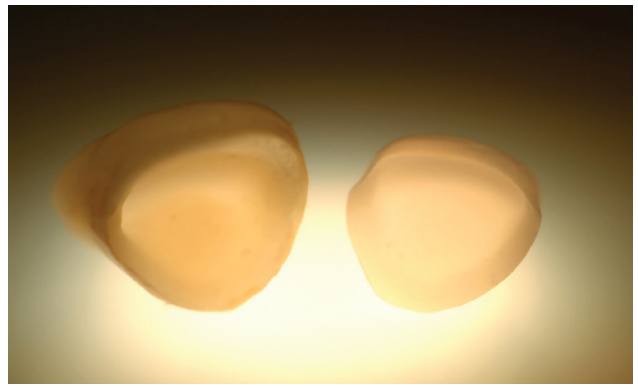


Figure 4. Zirconia coping and porcelain thickness were used in an attempt to control light artificially. When porcelain is built up on the zirconia coping, the image changes completely. Thinking of the transmission of light as another colour when considering the depth of the porcelain is bound to produce favourable results.



Figure 5. Zirconia copings - Options 1-4.

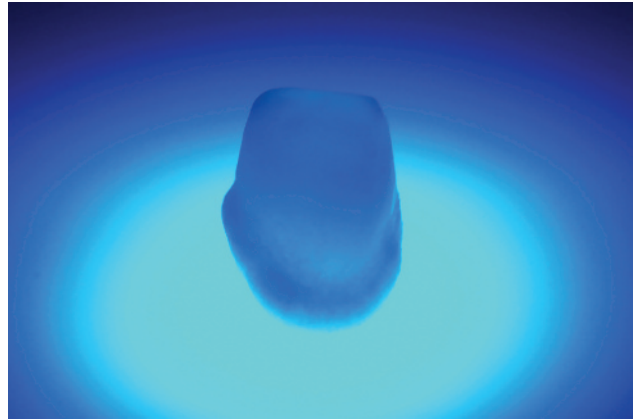


Figure 6. The use of margin porcelain to compensate for zirconia's lack of fluorescence provides excellent results in the mouth.

ceramic restoration. Due to its high biocompatibility and characteristic similarity to the look of natural teeth, more clinicians are opting to use zirconia and successful results are being achieved. It has had a major impact on the way in which dental technicians practise their craft, enabling us to meet the aesthetic demands of patients to the greatest extent possible. It is these benefits and success rates that, in the author's opinion, have helped establish today's "aesthetic dentistry".

Using some of the author's own clinical cases as case studies, this paper will present a number of different options for the use of zirconia, focusing on colour control when using zirconia copings and the relationship between zirconia and stump shade (Figure 1).

### Characteristics of zirconia

When describing the characteristics of zirconia, comparisons are invariably made with metal restorations. The greatest difference between zirconia and metal is how well they are able to absorb external light. Zirconia has the ability to control external light. Reflecting and transmitting light inside the mouth, zirconia interplays with the remaining tooth structure (stump) to create a depth of colour and conditions that closely resemble natural dentition.

In particular, the dental technician with a good grasp and understanding of the characteristics (advantages and disadvantages) of zirconia copings will find it much easier to work on the model and will be able to create anterior restorations that are much more natural in appearance. It is this point that the author believes has been most responsible for the rapid uptake of the use

of zirconia. However, the ability of zirconia copings to transmit light is both an advantage and a disadvantage. The fact that light can pass through the zirconia coping means that it is affected by the colour of the prepared tooth (stump) underneath, so the dental technician needs to know as much as possible about the stump shade before commencing fabrication of the restoration.

Of course, zirconia is not indicated for all cases. For example, if a metal core is being used as the stump, while it would not be impossible to use zirconia, other methods would probably be more suitable. Even if, after being told it would be impossible, the dentist or patient still insists on using zirconia, then there are a variety of different methods that could be adopted to accommodate that request. Having said that, the author believes that it would not be the best option. The best approach to such cases may be to explore all the possibilities and select zirconia as one of those options.

As mentioned before, in the author's opinion, zirconia offers many excellent benefits that will help dental technicians to achieve the objective of mimicking the shades of natural dentition as much as possible. Nevertheless, it is by no means perfect. Zirconia crowns, which comprise a zirconia coping and porcelain, are said to be similar to natural teeth in terms of the colour effects that they produce, but where they differ from natural dentition is in their shade effect and in their properties vis-à-vis external and internal light. That is why it is absolutely imperative that technicians acquire assured skills that will enable them to compensate for those subtle differences (Figures 3 and 4).

### Selecting the right kind of coping - 4 options

In recent times, it has become possible to add colour to the zirconia copings themselves by permeating them with a tinting solution. This opens up many new possibilities for the dental technician. The author has divided the possible ways of replicating natural shades when using zirconia copings into four broad categories. When selecting the best option, the technician should consider such factors as the desired chroma, value and hue of the tooth, stump shade and porcelain room (Figure 5).

#### *Option 1: Use the white coping as is*

This option would predominantly be used in cases where a bleached white shade is desired. The dental technician can take advantage of the white colour of the zirconia coping itself, enabling the production of a bright, white restoration without lowering the value.

#### *Option 2: Apply a stain or shade base to the white coping to control the colour and value*

The white coping may be considered as a blank white canvas to which colour can be freely applied, enabling subtle expressions of colour to be achieved. Because the desired colour result can be checked as it is being produced, it is possible to replicate shades that are closer to the ideal on the coping.

#### *Option 3: Use a coloured coping as is*

This option is suited to cases in which four or more colours are to be used. As long as the correct coloured coping for the desired result is selected, the colour of the coping itself will be of great assistance in the actual production of the restoration on the model.

#### *Option 4: Apply a stain or shade base to the coloured coping to control the colour and value*

This is the same procedure as Option 2, but after selecting a zirconia coping that is already coloured, more colour is applied. Caution should be exercised when using this method to ensure that the colour does not become too strong.

### Advantages of porcelain margins

Aesthetic dental restorations demand an exceptionally high degree of skill and precision. In particular, when recreating the shades in the area around the cervical line, the dental technician needs to take into account the relationship between the tooth colour and the gums. Margin porcelain, which is used to control the shading near the cervical line, is a preliminary task undertaken prior to shape restoration. Failure to do this properly could potentially adversely affect subsequent tasks and even the final result in the mouth. The author uses porcelain margins in almost 100% of his clinical zirconia cases, but there are cases in which it is not needed, the reasons for which are explained below.

#### *Criteria for determining the need for margin porcelain*

The following three criteria can be used to determine whether or not the use of margin porcelain is necessary.

1. When the smile line (lip position) is lower than the cervical line;
2. When the margin is set in deep; and
3. When there is insufficient shaping of the shoulder.

However, in the author's opinion, there are cases in which, even with the existence of the above, margin porcelain is not required.



Figure 7. Natural Die Material (Ivoclar Vivadent).



Figure 8. Creating custom original stumps creates conditions that better resemble the actual conditions in the patient's mouth.

#### *Advantages and properties of porcelain margins*

In cases that do require the use of margin porcelain, as mentioned above, the dental technician must take into account the relationship between the tooth colour in the vicinity of the margin and the gums when recreating the shading. Margin porcelain is, in the author's opinion, an absolute requirement in this regard. The major difference between zirconia copings to which margin porcelain has been applied and those without it is the lack of translucence in the latter. While zirconia alone does possess a certain amount of translucence, it is, in the view of the author, not enough to achieve a satisfactory result. Also, with zirconia alone, the way in which the light, both inside and outside the mouth, is reflected by the zirconia results in the cervical line appearing unnaturally bright.

By far the greatest difference between zirconia-only copings and zirconia with margin porcelain is fluorescence. Because zirconia copings do not have fluorescence, the shading near the cervical line becomes opaque, which is a fatal flaw in all-ceramic restorations. On the other hand, because porcelain is fluorescent, using margin porcelain can compensate for this disadvantage (Figure 6).

For the reasons described above, the author believes that margin porcelain is an extremely important and necessary part of zirconia restorations.

### Understanding stump shade

In all types of all-ceramic prosthetic restorations, not just zirconia, something that must not be forgotten is stump shade. As noted above, when an all-ceramic prosthesis is cemented into the patient's mouth, it must not be forgotten that stump shade will form part of the colour of the prosthetic surface. It is vital, therefore, that the dental technician obtain information about the stump shade in the shade-taking process.



Figures 9a-c. Demonstrating the importance of compensating for stump shade. Left: A simulated natural stump (11) and metal core (21); Centre: Identical zirconia copings show how the metal core overwhelmingly affects the shade; Right: The colour of the metal core is completely invisible after completion of the crown thanks to differing porcelain build-up techniques.



Figure 10. After glazing, always moisten the die material before checking the crown.



Figures 11a-b. The more the dental technician knows about the conditions inside the patient's mouth, including stump shade, the easier it will be to respond accordingly. These photographs show a case in which a zirconia crown was fitted over a post and core, but it is impossible to tell the stump colour from the crown.

Stump shade has the potential to affect the restoration immensely, but this is not something that can be easily determined merely from working on the model. For example, let us suppose that there was no photograph in the information received from the dentist, but the instructions from regular shade-taking was for a tooth colour of A1. The dental technician would therefore have no hesitation in using a regular shade guide to create the restoration with the A1 shade. Let us assume, however, that the stump over which the restoration is to be fitted is a metal core that is silver in colour. This means that the metal colour will show through the restoration, which will appear darker than A1 and it will have to be re-made. There are undoubtedly many dental technicians who have experienced this kind of thing. And, in many instances, this mistake was probably repeated without trying to resolve the cause of the problem. This becomes a cause of considerable stress not only for the dental technician but also for the patient. To avoid even one re-make, it is essential that the dental technician know about the stump shade.



Figures 12a-b. Checking the stump shade in the mouth. The dentist should information about the prep to the technician, particularly the stump shade.

One solution for such problems that the author uses, besides the use of images, is to replicate the stump shade on the model. This is done by using Natural Die Material (Ivoclar Vivadent) (Figure 7). Adding colour to this die material to create a custom original enables the dental technician to recreate a more realistic stump (Figure 8).

### Metal cores and zirconia copings

In Figure 9, the conditions inside the mouth have been artificially recreated to test the colour of the restoration. For tooth 21, the use of a metal core is

assumed (Figure 9a). The right and left crowns are both made with zirconia copings, but the one with the metal core is overwhelmingly affected by the stump shade, lowering the value of the zirconia coping (Figure 9b). However, the colour of the metal core, which was visible through the zirconia coping, is completely invisible after completion of the crown (Figure 9c). By building up the porcelain differently on the right and left, the same colour result is achieved. Developing these kinds of very sophisticated techniques is a valuable weapon for the dental technician.



*Figures 13a-d. Information about conditions in the mouth that cannot be measured from the model alone. Stump shades come in many varieties and the dentist must communicate this to the technician. Seen here are 4 common scenarios.*

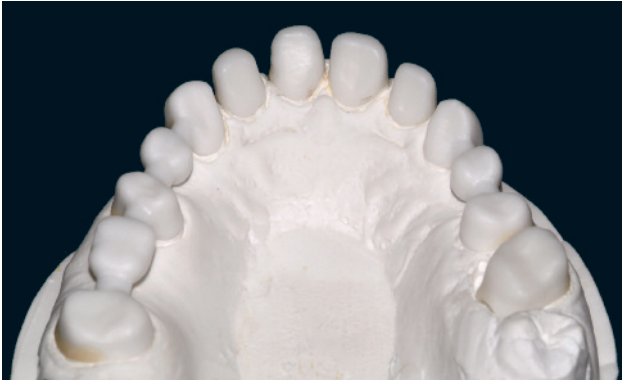


Figure 14a. White zirconia coping on the model.

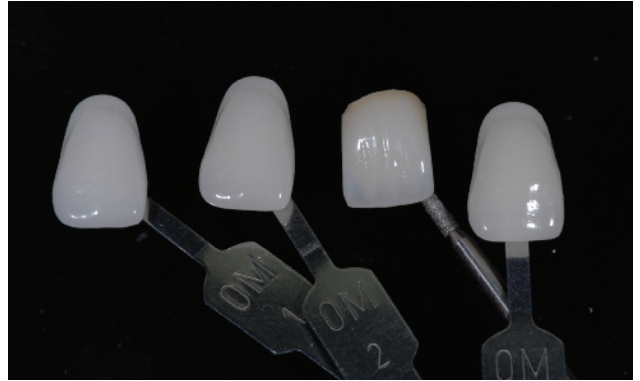


Figure 14b. When making the test piece, as well as getting as close to OM1 and OM2 as possible, a porcelain formula that was better suited to the patient was developed.



Figures 14c-e (Above). Initial consultation.



Figures 14f-h (Below). One month post cementation.



### Case study using Option 1

Using the conditions of Option 1, the bright colour of the white zirconia coping is used as is.

The female patient in her late thirties presented with a request for aesthetic restorations. The stumps showed severe discolouring. However, because the patient asked for OM1 and OM2 on the VITA 3DMASTER shade guide, it was decided to respond to the patient's wishes by using the white zirconia coping as is, with the aim of ensuring a natural appearance through the shaping of the teeth. In this way, the value would not be lowered, meanwhile the stump shade could be blocked out with the zirconia coping.

The Figures 14a-h show the restorations one month after cementation. The gum tissue is recovering and the results have met the patient's wishes to the maximum extent possible. In cases where the patient wants bleached white teeth, the colour can become very one-dimensional. The author believes that the best way to create a natural appearance is through the shape of the restoration.





Figure 15a. Due to double-scanning, the coping was designed from a wax-up.



Figure 15b. View from lingual side. The entire lingual surface was covered with zirconia to prevent fracturing.



Figure 15c. Wax-up coping and zirconia coping.

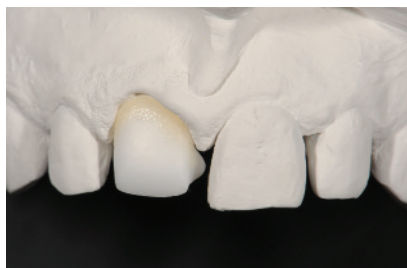


Figure 15d. Margin porcelain was fired on zirconia coping produced with a scanning system (Stoneglass Industries).

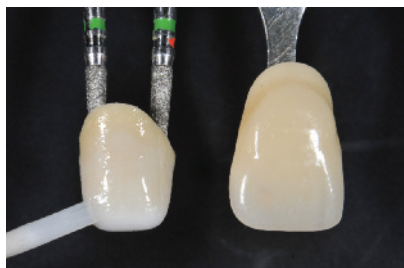


Figure 15e. Stains were painted onto the white zirconia coping to apply colour to better resemble the desired tooth colour (Noritake CerabienZR; Alfabond).



Figure 15f. After firing of the stains.



Figure 15g. Stump shade should also be checked during the shade-taking process.



Figure 15h. Temporary crown in situ.



Figure 15i. Blending in with the surrounding dentition in the mouth is the most desired result.



Figures 15j-l. One week post cementation.



## Case study using Option 2

This case uses the conditions of Option 2, in which a stain or shade base is applied to the white coping to control colour and value.

The patient, a male in his mid-forties, requested aesthetic restoration that would retain the diastema. Also, due to the patient's severe overbite, it was decided to coat the entire lingual surface with zirconia. Because the patient expressed dissatisfac-

tion with the temporary crown that had been fitted, a complete review was undertaken in an effort to achieve patient satisfaction.

In the author's opinion, Option 2 is the most suitable option for single central restorations with complex characterisations. The main reasons for this are that colour and value can be controlled freely and that, by bringing out the required colour from within, it is possible to reproduce the depth of natural dentition, thus producing restorations that better mimic natural teeth (Figures 15a-l).



Figure 16a. Preparation. The discolouration on tooth #22 needed to be taken into account when fabricating the restorations. Using the same coloured coping for all four teeth could be expected to have the effect of blocking out the stump shade.



Figure 16b. Using a coloured coping led to successful blending in with the remaining dentition without lowering the value.



Figures 16c-d (Above and below). One week post cementation.



### Case study using Option 3

Using the conditions of Option 3, the coloured zirconia coping is used on its own.

The male patient in his early thirties presented requesting aesthetic restoration of four anterior teeth. The restorations needed to be fabricated to match the colour and shape of 13 and 23, which were to be retained. However, the colour of the four anterior teeth also needed to match each other aesthetically. Shade-taking revealed that the shade of the remaining teeth was close to A2, so it was decided to use a coloured zirconia coping (Figures 16 a-d).



Figure 17a. Examination of the stump on the model.



Figure 17b. Preparation. The author ascertained during the shade-taking process that the stump shade presented no problems.



Figures 17c-d. Two weeks post cementation.



Figure 17e. The crown harmonises well with the patient's lips. It is virtually impossible under everyday circumstances to tell that the patient has a crown.

### Case study using Option 4

Using the conditions of Option 4, stains and shade bases are applied to a coloured coping to control colour and value.

The patient, a male in his early thirties, presented with a fractured laminate veneer. The stump was re-prepared and the restora-

tion achieved with a zirconia crown. An absolute condition of this restoration was that it matches the colour and shape of the existing natural dentition. The author noted that the natural dentition was quite dark in shade and that the incisal parts had no translucence. In such cases, after selecting

the appropriate coloured zirconia, the author saw the need to use stains to control the colour further and to bring out the desired depth (Figures 17a-e).

## Conclusion

With the growing diversity of all-ceramic materials for anterior restorations in the global dental profession today, the advances in CAD/CAM technology have been particularly striking. Zirconia has today become an indispensable option for anterior aesthetic restorations. As dental technicians, our goal is to fabricate restorations that resemble natural dentition as much as possible with materials that differ completely from natural teeth. Success in achieving this goal must first start with understanding the properties of the material being used. The key to success is how we can recreate artificially on a limited space the countless characterizations found on natural dentition. At the same time, the restorations we dental technicians produce must be aesthetically pleasing and must also function properly.

In this paper, the author has referred to colour control in anterior restorations using zirconia coping. Technological advances are being made in leaps and bounds and new materials are emerging every day and we are blessed with an environment that allows us to choose the most appropriate material for each of the cases with which we are presented. This means, however, that we need to know which material is best for each clinical case, so we must gather information about the different materials.

Communication between the dentist, who provides information about the conditions inside the patient's mouth, and the dental technician, who has the technical information on the model, and mutual understanding of each other's information will lead to success in aesthetic restorations. For the sake of the patient, it is vital that there be no distance between them.

The cases presented in this paper were not undertaken for the purpose of demonstration. They are actual clinical cases from the author's day-to-day work and, as such, are by no means exceptional cases. The author acknowledges with gratitude the cooperation of Omega Ceramics Dental Laboratory, which provides the author with the time and opportunities to pursue such cases.



*Figure 18. How much do dental technicians remember the clinical cases that they work on on a day-to-day basis? In the event of re-makes or other problems, it is easier to jog the memory if careful notes have been kept about the unique porcelain formulae created by the dental technician to replicate shades and other aspects of the case. The author files such notes for all clinical cases in which he is involved.*

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## About the author

After graduating from Tokai Medical Dental University (Department of Dental Technology) in 1998, Taishi Kodama advanced to the Post Graduate Course at the Master Ceramist School in Japan (Nagoya) of world-renowned ceramist Yutaka Miyoshi, completing the course in 2003. He started his career as a dental technician in 1999 and moved to Melbourne, Australia to join Omega Ceramics Dental Laboratory in 2003, where he specializes in ceramic restorations. He has published an article on "The Final Result Zirconia Crown Using the Stone glass System" in ZERO (Zero publishing) and he has served as a special lecturer at a meeting to discuss "The Esthetic Design" by Study group JDI. He is currently the head ceramist at Omega Ceramics Dental Laboratory, was a Noritake instructor in 2010 and is a member of the DE-One Study Group.

## About DE-One Study Group

DE-One was formed in 2009 by four ceramists to contribute to society through the advancement of technology, knowledge and the development of the dental industry for improved patient outcomes. They are also committed to maintaining broad perspectives as a group and passing on our knowledge and skills to the next generation.