

# The Essence of Fluorescence

## Understanding the Role of Ceramic Layering on Fluorescence when Fabricating Esthetic Ceramic Restorations

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**Key Words:** fluorescence, value, shade matching

### Introduction

Fluorescence results when an object absorbs a shorter wavelength of light and spontaneously emits a longer wavelength, making it brighter than a non-fluorescent object.<sup>1</sup> Classically considered in the context of exposure to ultraviolet (UV) light, the most striking examples of fluorescence occur when the absorbed light is in the UV range of the spectrum, thereby invisible to the human eye, and the emitted light is in the visible range.<sup>2-4</sup> Sunlight and most fluorescent tubes emit small amounts of UV light.

Some objects—including teeth—are naturally fluorescent and will emit a “bluish-white” light in the visible spectrum, a form of luminescence, which adds to their perceived value (i.e., brightness) (Figs 1 & 2).<sup>1</sup> Materials that do not fluoresce will be perceived as slightly darker (i.e., lower value) than materials that do fluoresce if all other color attributes are the same.



**Figures 1 & 2:** Natural dentition under corrective light and UV light.

## Fluorescence in Dentistry

The many practical applications of fluorescence and its modification in restorative dentistry include blocking dark stump shades, increasing the value of the restorations through luminescence, and minimizing the metameric effect between natural tooth structure and restorative materials under various lighting conditions.<sup>5</sup> Additionally, restoring dental fluorescence is important for patients who are regularly exposed to UV light (e.g., models involved in fashion shows).<sup>6</sup>

To achieve an accurate shade/color match among restorations and/or natural teeth, it is extremely important to consider a restorative material system's fluorescent properties when treatment planning. As we know, ideally blending restorative materials is predicated on first matching value, which again is influenced by fluorescence. Generally speaking, the greater the fluorescence, the higher the value. When the color saturation and chromacity of a restorative material increase, its fluorescence decreases.

As such, a material's inherent fluorescence can help to increase the perceived value of restorations without the need to add reflective opacity. Because dentin is more fluorescent than enamel in natural teeth, any modifications to fluorescence should be made in the dentin layer when creating ceramic restorations (Fig 3).<sup>1,7</sup>

Therefore, detailed communication between clinicians and laboratory technicians should focus on recreating natural-looking reflection and fluorescent light dispersion characteristics. This will help to avoid selecting a restorative material with low or incorrect fluorescence.<sup>8</sup> However, such consideration is predicated on an understanding of the optical properties of available ceramic materials—especially their fluorescent characteristics—and how to manipulate them to achieve natural-looking esthetics, without exaggerated or incorrect value.

## Fluorescence results when an object absorbs a shorter wavelength of light and spontaneously emits a longer wavelength...

### Fluorescence of Lithium Disilicate

A variety of esthetic restorative materials have been introduced over the past 25 years to enable dentists and dental technicians to satisfy the treatment demands of more esthetically conscious patients. The physical and esthetic properties of these materials, and their applied techniques, have continually improved. As a result, today's materials achieve lifelike esthetics, along with a combination of adequate strength to withstand functional loading by masticatory forces, chemical stability under intra-oral conditions, and high stability.<sup>9-11</sup>

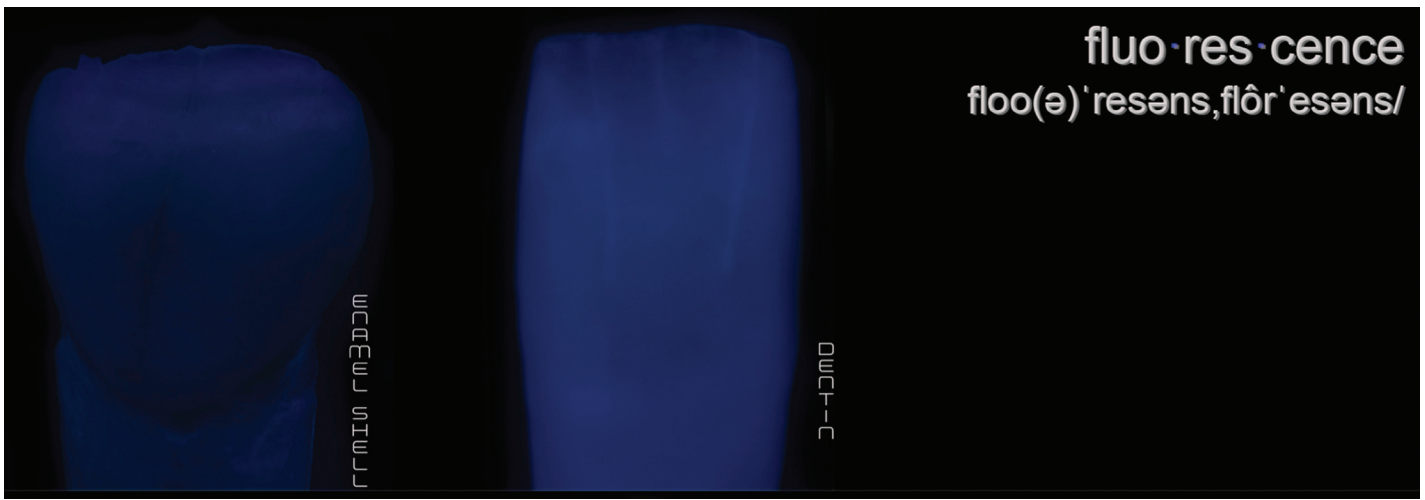
Among them are leucite-reinforced glass ceramics (e.g., IPS Empress, Ivoclar Vivadent; Amherst, NY) and lithium disilicate (e.g., IPS e.max, Ivoclar Vivadent). Optically, lithium disilicate materials demonstrate properties very similar to those of leucite-reinforced glass ceramics, and multiple ingot shades and translucencies are available. However, the lithium disilicate material exhibits lower fluorescence than the leucite-reinforced glass ceramic, and the extent of fluorescence varies among the different ingots (Fig 4).

To better understand and evaluate the fluorescence of lithium disilicate—and to determine the best approach for increasing fluorescence in lithium disilicate restorations—a test was performed on four sets of full-coverage crown restorations (IPS e.max Press). The crowns were fabricated using the lowest-fluorescence ingots to identify how best to enhance fluorescence.

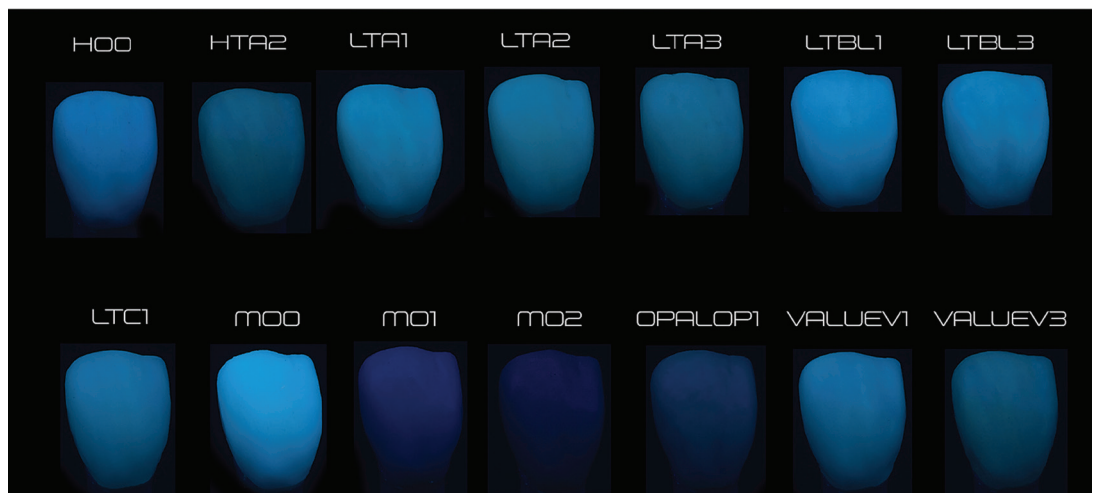
For each crown, one side (i.e., right side of each crown) was pressed to full contour, and the other side (i.e., left side of each crown) was designed as a coping for layering ceramic. Each crown was created with approximately 1.0 mm thickness of layering space. In particular, two crowns were pressed with high-translucency (HT) ingots in shade A2 (referred to as #1 and #2), and the other two crowns were pressed with medium-opacity (MO) ingots in MO2 (referred to as #3 and #4) (Figs 5-7).

A bonding layer was applied to the restorations to approximately 0.1 mm thickness (Fig 8). One HT A2 crown (#1) and one MO2 crown (#3) were bonded using a glaze paste (Fluor Glaze; Ivoclar Vivadent). Additionally, one HT A2 crown (#2) and one MO2 crown (#4) were bonded using a Mamelon Light powder. All four crowns were then layered with Transpa Incisal 2 and D3 Dentin ceramics (Figs 9 & 10).

The crowns were evaluated after layering. Compared to the full-contour pressed half (i.e., right side of each crown), the layered half (i.e., left side of each crown) exhibited much higher fluorescence (Fig 11).



**Figure 3:** Enamel versus dentin. Dentin is more fluorescent than enamel under UV light. This greater fluorescence results from the higher organic content of dentin.



**Figure 4:** Samples of IPS e.max Press ingots formed into monolithic crowns, without layering, under UV light. Note that the MO1 and MO2 crowns demonstrate low fluorescence.



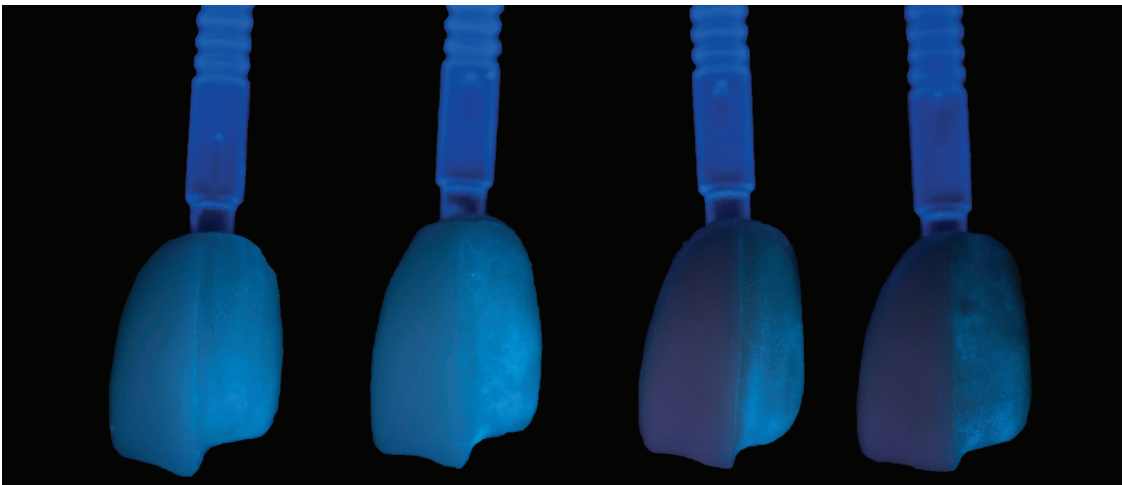
**Figure 5:** Two lithium disilicate crowns were pressed with HT A2 ingots (left) and the other two crowns were pressed with MO2 ingots (right).



**Figure 6:** We selected two of the most low-fluorescence ingots in their category to better compare the fluorescence.



**Figure 7:** The two crowns (#1 and #2) pressed with the HT A2 ingots appear on the left, while the two crowns (#3 and #4) pressed with the MO2 ingot appear on the right.



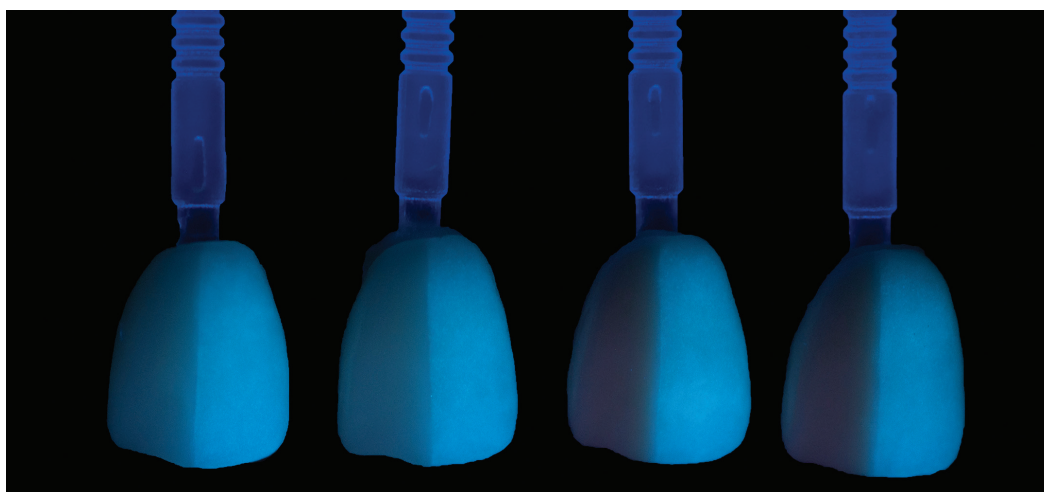
**Figure 8:** One HT A2 crown (#1) and one MO2 crown (#3) were bonded using a fluorescent glaze paste, and one HT A2 crown (#2) and one MO2 crown (#4) were bonded using a high-fluorescence powder.



**Figure 9:** Transpa Incisal 2 and D3 Dentin ceramics were selected for layering the crowns.



**Figure 10:** All four crowns layered with the Transpa Incisal 2 and D3 Dentin ceramics.



**Figure 11:** Compared to the full-contour pressed half (i.e., right side of each crown), the layered half (i.e., left side of each crown) of #1 through #4 exhibited much higher fluorescence.

## Tips

- To achieve an accurate shade/color match among restorations and/or natural teeth, consider a restorative material system's fluorescent properties.
- Remember that material fluorescence can help to increase the perceived value of restorations without the need to add reflective opacity.
- When creating ceramic restorations, any modifications to fluorescence should be made in the dentin layer, since dentin is more fluorescent than enamel in natural teeth.
- When a high-fluorescence ingot is not ideal, a low-fluorescence ingot can be selected, and fluorescence/value increased, by pressing the material similarly to a coping and then layering with a high-fluorescence powder or a fluorescent glaze paste.

To further assess how to influence fluorescence in lithium disilicate restorations based on an ingot's optical properties, Fluor Glaze paste was then applied only to crowns #1 (i.e., the HT A2 ingot) and #3 (the MO2 ingot) and fired. The result was a slight increase in fluorescence (Fig 12).

Then, the layered half (i.e., left side of crown) of all crowns was glazed with the Fluor Glaze paste. As a result, all crowns demonstrated much higher fluorescence on the layered half compared to the full pressed half (i.e., right side of crown) (Fig 13). However, when Fluor Glaze paste was applied and fired on the full-contour half of all crowns (i.e., right side of crown), the level of fluorescence did not increase much (Fig 14).

It is important to note that other glass ceramic ingots (e.g., VITA North America; Yorba Linda, CA) are also available. Similar fluorescence modification evaluations on crowns fabricated from VITA PM9 ingots produced similar results.

**Materials that do not fluoresce will be perceived as slightly darker...than materials that do fluoresce if all other color attributes are the same.**



**Figure 12:** Applying and firing Fluor Glaze paste to crowns #1 (i.e., the HT A2 ingot) and #3 (the MO2 ingot) slightly increased fluorescence.



**Figure 13:** After glazing with Fluor Glaze, the layered half (i.e., left side) of all crowns demonstrated much higher fluorescence than the full pressed half (i.e., right side).

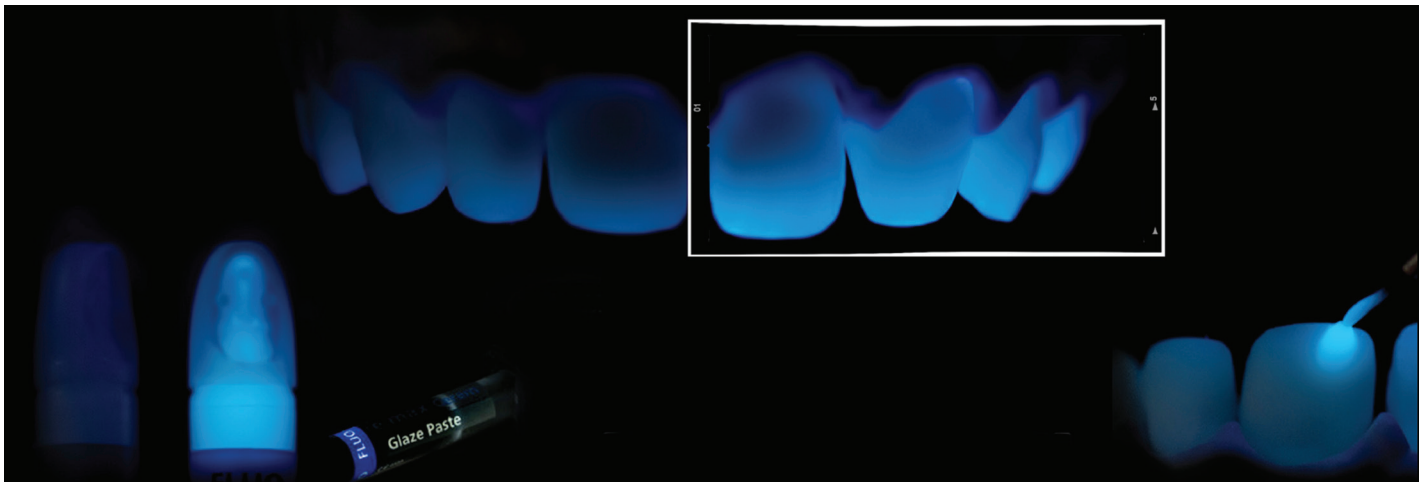


**Figure 14:** When Fluor Glaze paste was applied and fired on the full-contour half (i.e., right side) of all crowns, the level of fluorescence did not increase much.

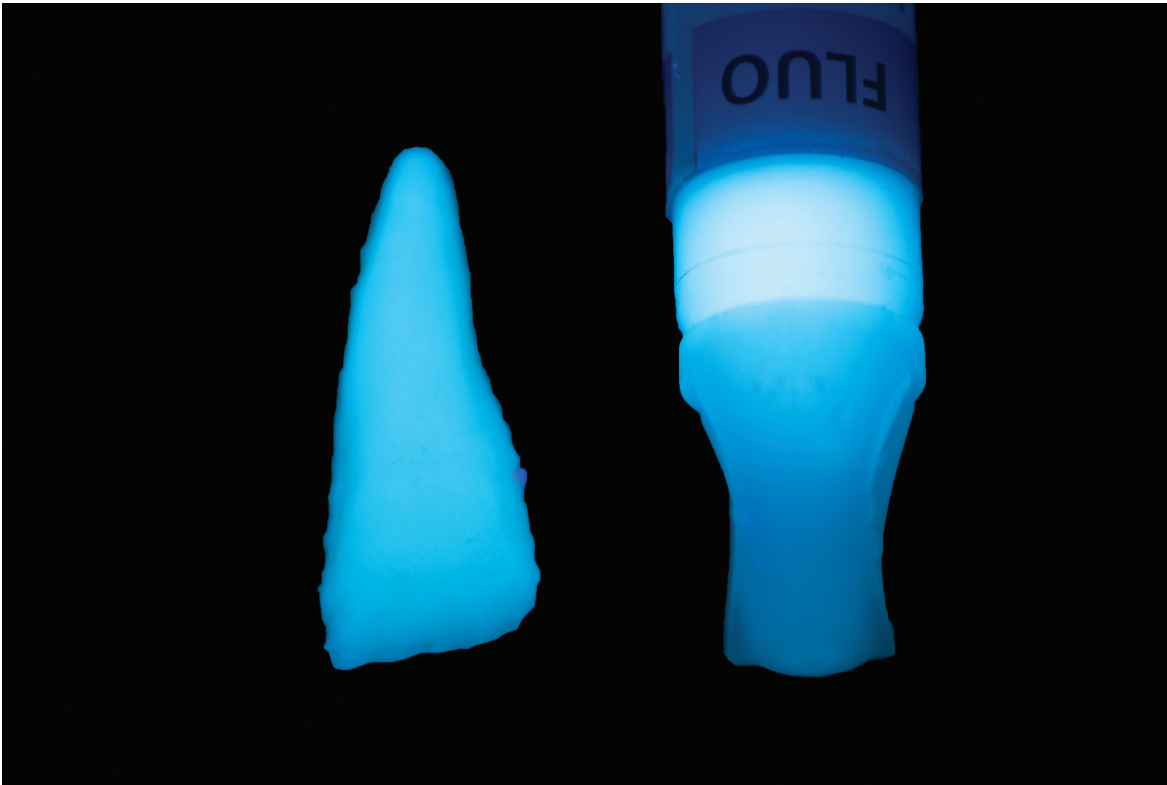




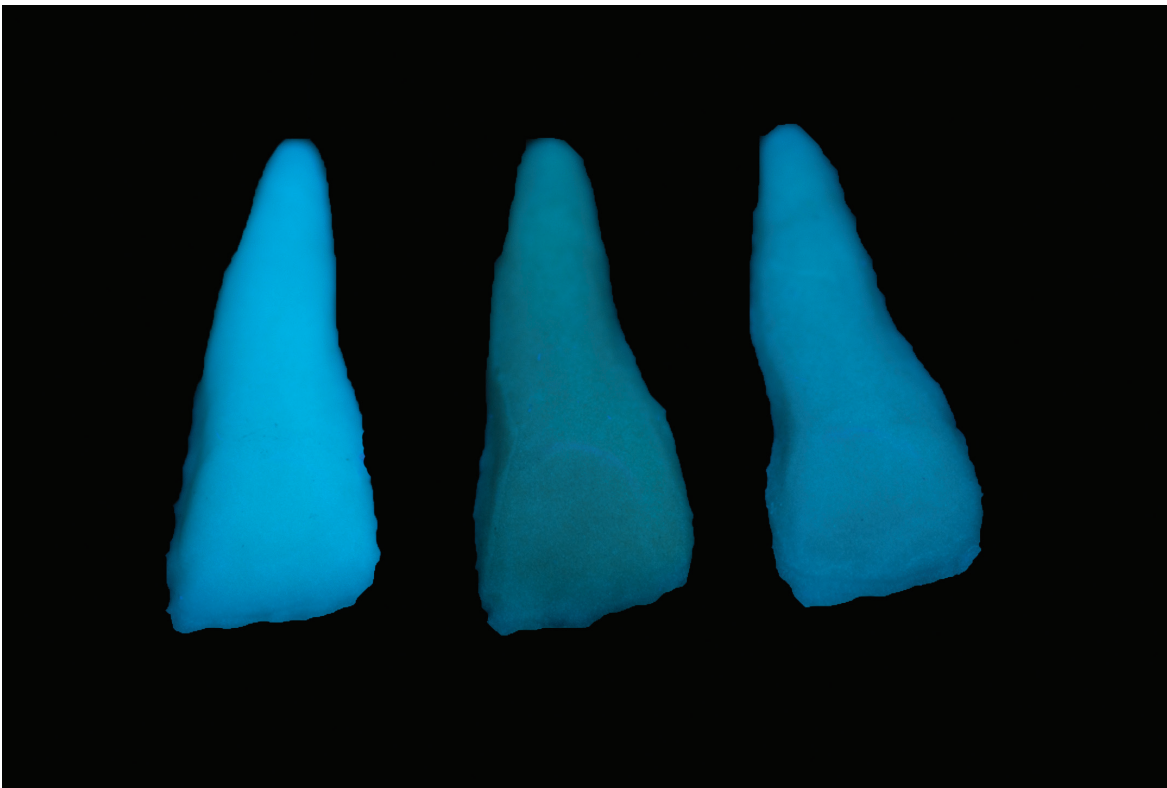
**Figure 15:** A sample of IPS e.max Ceram powders, all of which demonstrate fluorescence.



**Figure 16:** Clinical case showing the left side of an arch restored with a lithium disilicate coping (e.g., IPS e.max Press MOi ingot) layered with Fluor Glaze paste to increase the fluorescence.



**Figure 17:** Although most of IPS e-max Ceram powders demonstrate fluorescence, the highest-fluorescence powder is Mamelon Light.



**Figure 18:** IPS e.max Ceram powders in (left to right) Mamelon Light, Mamelon Salmon, and Mamelon Yellow Orange.

## Summary

To increase fluorescence in lithium disilicate restorations, the dental ceramist can select a high-fluorescence ingot. However, there are times when, depending on the desired final shade of the restoration, using a high-fluorescence ingot is not ideal.

Therefore, when a low-fluorescence ingot is needed, value can be increased by pressing the material similarly to a coping, and then layering with high-fluorescence powder or a fluorescent glaze paste (**Figs 15 & 16**). By using these two high-fluorescence materials, a much greater level of fluorescence can be achieved than with full-contour pressed restorations (**Figs 17 & 18**).

## Acknowledgment

*The authors thank Andy Kim, MDC (Los Angeles, CA), for his collaboration on this article.*

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## When the color saturation and chromacity of a restorative material increase, its fluorescence decreases.



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Disclosures: Dr. Figueira and Mr. Park did not report any disclosures.

Dr. McLaren received the materials in this study for testing from Ivoclar Vivadent, but did not receive any financial remuneration for co-authoring this article.