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A Simplified Aesthetic Concept

Historical Review and Current Clinical Application



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To fully understand the historical progression of any approach to treatment, a clinician should study the past. The restorative dentist must consider advances in material science as part of a continuum. The knowledgeable clinician will be prepared to incorporate new concepts into an existing paradigm.

Traditionally, hybrid composite resin was used because of its strength and fracture resistance, whereas microfill resin was developed to attain not only improved polishability, but to maintain the durability of the polish. However, it was soon discovered that this process of stratification, which used the attributes of both the hybrid and the microfill to create an optimal restoration with enhanced mechanical properties, provided another advantage: a variation in the shades and opacities of color. This created a 3-dimensional effect—the polychromatic effect.^{1,2} By using an anatomic stratifica-

tion with successive layers of dentin and enamel, a more realistic depth of color could be achieved,³ as well as surface and optical characteristics that mimic nature.^{4,5} Therefore, past clinical and scientific efforts to create a more ideal restorative material for function and anatomical form resulted in the development of color within a restoration, not simply on the surface.

Advances in restorative materials continue to enhance the practice of dentistry. Newer formulations of composite resin systems have improved physical, mechanical, and optical characteristics that are directly related to the filler particle size, distribution, orientation, and quantity. Prior to the introduction of the small-particle composite resin, it was often necessary to combine hybrid and microfilled composites to achieve proper aesthetics (ie, luster, color) and mechanical stability (ie, strength, wear



Figure 1. Developing natural tooth anatomy with composite resin requires a similar orientation of artificial enamel and dentin. Newer formulations of composite resins possess many of the secondary optical properties that render a tooth polychromatic.

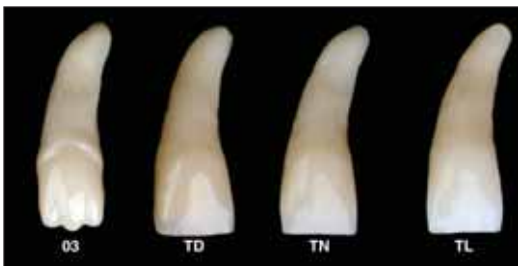


Figure 2. An identical O3 opaque dentin shaded composite substrate (O3) is overlaid with 3 different translucent enamel shaded composites: translucent dark (TD), translucent neutral (TN), and translucent light (TL).



Figure 3. Preoperative occlusal view of defective amalgam restorations with recurrent caries on the maxillary first and second premolars.

resistance, fracture resistance) in adhesive restorations. Since the development of the small-particle composite resin, it appears that these properties have been incorporated into a single restorative material. Although polychromatic stratification techniques are still necessary with this revised

composite resin formulation, they are used only to attain natural aesthetics and color rather than to improve physical characteristics.

This article describes a simplified concept of utilizing an existing stratification technique with a new biomaterial to improve the clinical outcome.

NATURAL TOOTH AESTHETICS

The successful aesthetic reproduction of the natural dentition in terms of color requires an understanding of the interrelationship of optical properties and the morphology of the tooth. As light passes through the natural tooth, it is reflected, refracted, absorbed, or transmitted by the multilayered tooth structure that varies according to the optical densities of the hydroxyapatite crystals, enamel rods, and dentinal tubules.⁶ In natural teeth, different colors are distributed, and various optical characteristics are observed through the enamel and dentin.² This polychromatic effect manifests in different optical characteristics. These characteristics must be properly interpreted so the clinician and technician can fabricate aesthetic restorations.⁷ The dentin and enamel have dramatically different properties, and the relative contribution of each should be considered during shade determination and fabrication of an aesthetic restoration.

To describe tooth color and aesthetics appropriately, a broad definition has been given to color that is based upon anatomy, optical properties, and polychromaticity.⁸ This definition is based upon the relative contribution of dentin and enamel to the color of the natural dentition. The primary optical properties are defined as hue, chroma, and value. The dentin imparts all of the colors of a tooth (ie, determines hue and chroma),² while the enamel acts as a fiber-optic structure that conducts light to capture the underlying color of the dentin (ie, is a determinant of value).⁹ The secondary optical properties include translucency, opacity, opalescence, iridescence, surface gloss, and fluorescence. These secondary properties contribute significantly to the total aesthetics of the tooth, and may be bet-

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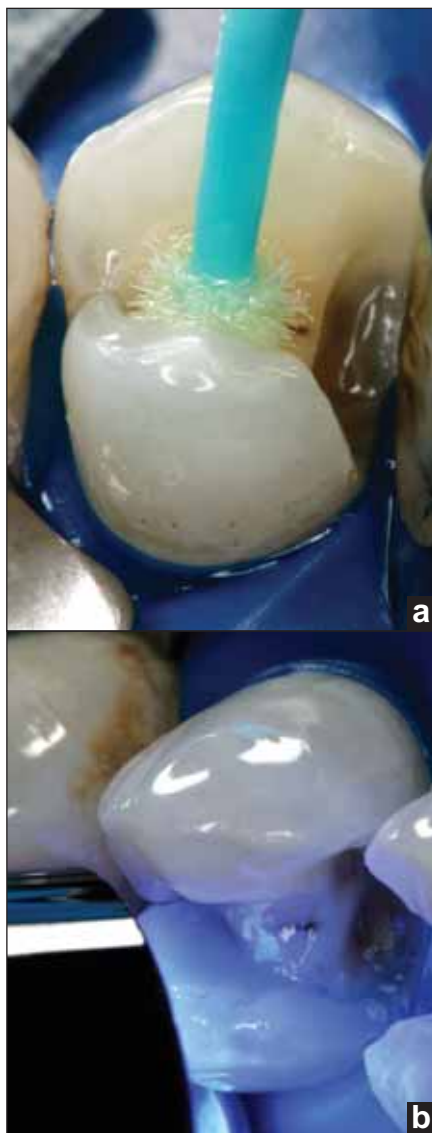


Figure 4. After acid-etching the enamel margins, a single-component self-etch dentin adhesive (Futurabond NR [VOCO]) was applied to the enamel and dentin (a), then air-thinned and light-cured (b).



Figure 5. A contoured sectional matrix band (Composi-Tight [Garrison Dental Solutions]) is placed (a), and an A-2 shaded flowable composite (Grandio Flow [VOCO]) is applied as a cavity liner and uniformly distributed on the pulpal floor (b) with a round-tipped instrument (PKT-3A [Brasseler USA]).

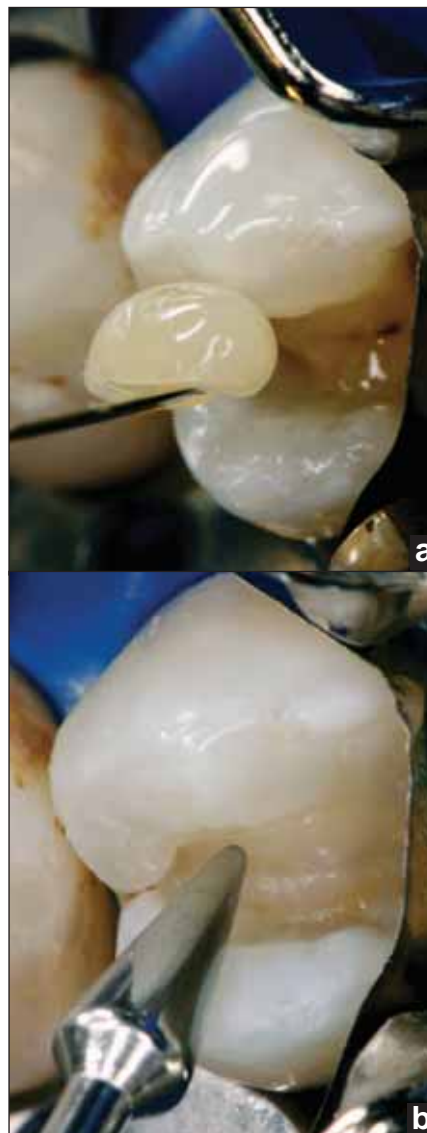


Figure 6. An elongated O2 opaque dentin shaded hybrid composite increment (Amaris) is placed (a), adapted in an oblique layer with a round tipped composite instrument (PKT-3A) against the cavity wall (b), and light-cured through the cusp using the ramp curing mode to minimize polymerization stresses and enhance marginal adaptation.

[Author: instrument in picture does not have a round tip. Please clarify.]



Figure 7. A final increment of enamel-shaded hybrid composite (Amaris) is placed (a), and the occlusal anatomy is developed with a PKT-3A (b).

ter explained in terms of tooth anatomy.

The degree of translucency or opacity is determined by the physical nature and the thickness of enamel and dentin, as well as the amount of light that penetrates the tooth or restoration. Although both dentin and enamel are translucent in the natural dentition, the enamel layer is virtually transparent and colorless.

Opalescence is primarily observed in enamel, and in teeth it has a light-scattering effect that is associated with the diameter of the enamel rods.

Iridescence produces a rainbow effect within the object being viewed. While colors change based upon alterations in the viewing direction, location, and illumination of an object, the manner in which these parameters change depends upon the wavelengths of dispersion, interference, and diffraction of light.

Surface gloss affects the appearance and vitality of teeth and aesthetic dental materials. The surface morphology of natural teeth influences the surface gloss. While macro- or micromorphologically roughened or coarse surfaces lead to diffuse reflection, flat or smooth surfaces allow specular (mirror-like) reflection. This optical scattering of light has an effect on color perception and translucency of the tooth.

Fluorescence occurs when ultraviolet (UV) light rays are absorbed and blue or white visible light is emitted. Due to the organic composition of dentin, UV light rays penetrate the enamel and excite the dentin photosensitivity (ie, sensitivity to the action of radiant energy, or the color response to light). The emitted light enhances the brilliance and vitality of teeth. Both dentin and enamel fluoresce, and the combination of these structures can enhance the whiteness or value of

teeth.

With this more comprehensive interpretation of color derived from an understanding of the interrelation of optical properties and tooth morphology, clinicians and manufacturers can work toward development of restorative systems (ie, composite, porcelain) that are capable of reproducing natural tooth color within a restoration.

COMPOSITE AND COLOR

Since no single monochromatic composite resin can duplicate the color evident in the natural dentition, it is necessary to select various colors for the artificial enamel and the artificial dentin layers. Accordingly, to reconstruct the natural polychromatic effect, the layers cannot be stratified in equal dimensions as is present in plexiglass, which is uniformly distributed in layers. Rather, an aesthetic restoration requires the irregular, undulated placement of

variations of composite resin colors. This allows light passing through the natural tooth and the restoration to reflect, refract, absorb, and transmit according to the optical densities of the hydroxyapatite crystals, enamel rods, dentinal tubules, and restorative material. Ideally, this creates a restored tooth with a multicolored, natural appearance.

Because composite does not have hydroxyapatite crystals, enamel rods, and dentinal tubules, the composite restoration requires the clinician to develop an illusion of the way light is reflected, refracted, transmitted, and absorbed by dentin and enamel microstructures.⁶

Recreating a natural anatomical surface requires a similar orientation of enamel and dentin. Newer formulations of composite resins possess optical properties that render the tooth polychromatic (Figure 1).

A variety of dentin shades and

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Figure 8. The completed composite resin restorations using the duo shade technique reflect the harmonious integration of anatomical form and color.



Figure 9. Preoperative lingual view of a defective composite restoration with discoloration and recurrent caries on a mandibular lateral incisor.



Figure 10. The restorative shade is determined by color photographic comparison to the natural tooth structure.



Figure 11. After the enamel cavosurface is acid-etched, a single-component self-etch adhesive (Futurabond NR) is applied, air-thinned, and light-cured.

translucencies are available, and enamel shades that are highly translucent, fluorescent, and opalescent have been developed. Utilizing

these composites, it is now possible for the clinician to fabricate a durable, long-lasting restoration that is aesthetically indistinguishable from natural tooth structure. Exact shade matching and localized characterization is entirely possible. However, with some composite systems the attainment of ultimate aesthetics is time consuming. Most composite systems have standard composite resin shade guides that are manufactured from unfilled methacrylates and do not accurately represent the true shade, translucency, or opacity of the final polymerized restorative material.¹⁰ Furthermore, the range of shades in these standard shade guides is not consistent with natural tooth color. In addition, many of the composite resins are synchronized to the Vita Lumin Shade Guide, which was designed for porcelain systems and not composite resin systems. Further, many of these composite resin systems do not correspond to the true Vita shades. These discrepancies are one reason for inconsistent color matching that requires a trial-and-error method through the fabrication of multiple custom shade tabs from the actual restorative material. Also, the use of color modifiers and opaquing resins can be required to modify and adjust composite color to attain all of the possible natural tooth colors.

A recently developed composite resin system (Amaris [VOCO]) may provide a solution to this problem. This system provides a simplified method of combining dentin color and enamel value in a way that mimics natural tooth structure and color. This concept was designed with consideration of both enamel and dentin shading instead of using a single monochromatic composite resin color. The idea that most of the color (ie, yellow, orange, and red) originates from the dentin is the key here, resulting in grouping Vita shades of similar hue and chroma to realistically replicate the optical properties of the natural tooth. The composite system has 6 base opaque dentin shades arranged according to increasing chroma. Three enamel translucent shades provide value (ie, brightness to the restoration) and the aforementioned secondary optical properties (ie, translucency, fluorescence, iridescence, and opalescence; Figure 2).

In addition, 2 special shades are provided: a high translucent and an opaque, shaded flowable composite. The high translucent shaded composite can be used for incisal edges, enamel or incisal defects, and to achieve a high-gloss surface reflectivity, while the opaque shaded com-

posite can be used for masking discolorations (ie, amalgam staining, or altered color transition that occurs when endodontic access openings are made in ceramic restorations). This concept provides 18 possible tooth color combinations synchronized to the Vita shade guide. Furthermore, this system's shade guides are manufactured from the actual composite resin material, and accurately represent the true shade, translucency, or opacity of the final polymerized restorative material. Therefore, the shade matching system provides optimal replication of dental composite color. This synchronization allows the clinician to compare the actual polymerized restorative material to the natural tooth color for a more accurate aesthetic color matching. This concept not only simplifies the replication of the optical properties of the natural tooth, but also provides consistent and predictable results.

The following clinical examples describe the process by which anterior and posterior composite resin restorations can be efficiently developed using the Amaris system.

DEVELOPING AESTHETIC RESTORATIONS USING A SIMPLIFIED PLACEMENT TECHNIQUE

Aesthetic restoration of the prepared tooth has been the subject of considerable discussion. A myriad of techniques have been developed to avoid the limitation of depth of cure, reduce the effects of polymerization shrinkage, improve marginal adaptation and seal,¹¹⁻¹⁵ enhance aesthetics,^{16,17} and enhance clinical outcomes of such procedures.¹⁸ The incremental stratification techniques include horizontal, vertical oblique, centripetal, 3-sided light-cure, and centripetal build-up. These various methods are recommended according to the type and dimension of the cavity preparation.¹⁹ It is commonly believed that segmentally filling the preparation generates the least pull on the buccal and lingual cusps. Not all literature agrees with that concept. Douglas and colleagues demonstrated that bulk fill produced the least strain on the opposing cusps.²⁰ Although stratification techniques allow the clinician to develop aesthetic restorations, the use of intricate multilayering with numerous shades of composite may not be efficient, realistic, or practical for the modern dental practice. In an effort to simplify and improve efficiency and provide optimal aesthetics, Amaris, a new nanocomposite formulation, was designed and integrated with the duo-shade modified placement technique for posterior



Figure 12. An increment of O3 shaded hybrid composite (Amaris) is applied as an opaque dentin core and light-cured for 40 seconds from the facial using the ramp curing mode to minimize polymerization stresses and enhance marginal adaptation.



Figure 13. A final dark translucent shaded enamel layer (DT) is applied (a), sculpted and smoothed with a sable brush (b), and post-cured for 60 seconds.



Figure 14. The postoperative result achieved with this simplified 2-layer nanocomposite system reveals the natural integration of composite resin with tooth structure.

and anterior composite restorations.

For posterior restorations (Figures 3 to 8), the technique involves use of one continuous increment (ie, tubular shaped) that is placed and adapted in an oblique layer against the cavity wall. A round-tipped composite instrument (PKT-3A [Brasseler USA]) should be used. The increment is cured through the cusp, and the pulpal floor becomes part of the cavity wall. This approach reduces the ratio of cavity volume to area of cavity wall, which results in a substantial reduction in the marginal contraction gap.²¹ A second elongated increment is adapted in the same oblique manner against the opposing cavity wall, and is then light-cured through the cusp. For small- to medium-sized occlusal and proximal cavity preparations, the internal dentin core requires 2 incremental placements. A final enamel layer is filled to the occlusal margins.

At this point a round-tipped instrument such as the PKT-3A is used to remove any residual composite material. Procedurally, the composite condenser is pressed against the occlusal surface. Using finger pressure, the instrument traces the entire margin of the preparation. This technique not only eliminates all residual composite extended beyond the preparation, but also fills any region that may have been underfilled. Upon completion, the same burnishing instrument can be used to develop the central fissure, buccal and lingual developmental grooves, and incline planes. After light-curing, the rubber dam is removed and articulating paper is employed to identify any premature contacts.

This same duo shade placement technique can be utilized in direct anterior composite restorations (Figures 9 to 14). However, polymerization shrinkage stress generated during fabrication of anterior composite restorations is less than for posterior restorations, since the ratio of bonded to unbonded surfaces is generally less for anterior restorations. Therefore, utilization of stratification techniques to minimize the effects of shrinkage stress is a less important consideration.

A long-bladed interproximal carver is preferred for resin placement and adaptation, and a sable brush is used to smooth the surface. A curved instrument (TINL-R [Brasseler USA]) can be used to shape the lingual surfaces of anterior restorations. For class III and IV composite resin restorations an opacous dentin increment is placed as the internal core, and a second

enamel layer encapsulates this core. For class V restorations, this same placement procedure can be utilized with a translucent or opacous dentin core, depending upon the color of the dentin substrate. For deeper cervical restorations, placement of the dentin core in 2 sequential increments and utilizing a lower intensity light power during the first 20 seconds of polymerization may result in an interval in which stress can be partly relieved by flow and elastic strain.²² The correlation between the rate of conversion and the rate of shrinkage stress development requires a slower stiffness development, which may result in overall stress reduction by allowing more yielding of the free surface of the restoration to the underlying contracting bulk.²³ The occlusal dentin segment (with a higher bond strength to enamel) is placed first, followed by the gingival segment. This approach reduces the potential for microgap formation at the gingival margin.

Creation of an aesthetic restoration depends on the clinician's understanding and interpretation of color and its relationship to the morphology of the tooth. The anatomy of the tooth should guide the clinician in developing the correct form and color. For optimal color matching of proximal composite restorations, consideration should be given to the surrounding environment. Composite resin, enamel, and dentin cause considerable light scattering, which produces internal diffusion of light and allows the composite restoration to blend with the tooth. This "chameleon effect" occurs as diffused light enters from the surrounding tooth, and when emitted from the restoration will alter its color by absorbing color from the tooth. This color alteration depends on the scattering and absorption coefficients, which can produce an appropriate color match.²⁴ The composite resin system discussed offers clinicians a more accurate and realistic representation of natural tooth color combinations. The duo shade technique creates high-diffusion layers that allow optimal light transmission within the restoration, providing a more realistic depth of color, as well as a natural appearing tooth surface.

CONCLUSION

Composite resin technology continues to improve the practice of dentistry. Technological advances allow the clinician to attain more predictable and aesthetic results. Clinical trials will be required to determine the long-term results of

restorations created with this new resin formulation. The clinical examples provided in this article demonstrate the ability of this nanoparticle hybrid formulation to simulate the optical properties of natural dentition. ♦

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University of Texas Health Science Center Dental Branch at Houston in 1978, where he is now an assistant professor of the department of restorative dentistry and biomaterials. He has published more than 230 articles on various topics in aesthetic dentistry in numerous languages and authored the textbook *Natural Aesthetics with Composite Resin.* He maintains a private practice in Houston emphasizing aesthetic and restorative dentistry. He can be reached at (281) 481-3483.

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continued on page XX

Continuing Education

Test No. 105.#



To submit Continuing Education answers, use the answer sheet on this page. On the answer sheet, identify the article (this one is Test 105.#), place an X in the box corresponding to the answer you believe is correct, detach the answer sheet from the magazine, and mail to Dentistry Today Department of Continuing Education.

The following 8 questions were derived from the article *A Simplified Aesthetic Concept: Historical Review and Current Clinical Application* by Douglas A. Terry, DDS, and Karl F. Leinfelder, DDS, MS, on pages # through #.

Learning Objectives

After reading this article, the individual will learn:

- the historical progression of aesthetic techniques for composite resin restorations, and
- a simplified aesthetic stratification technique.

- A variation in shades and opacities of color that creates the illusion of depth is called ____.**
 - translucent effect
 - polychromatic effect
 - opaque effect
 - hybrid effect
- Traditionally, hybrid composite resin was used for its ____.**
 - polishability
 - durability of polish
 - strength and fracture resistance
 - both a and b
- The combination of aesthetics and mechanical stability in a single composite resin material is possible due to ____.**
 - the development of hybrid composites
 - the development of microfill composites
 - the development of small-particle composites
 - the development of large-particle composites
- A primary optical property is ____.**
 - hue
 - chroma
 - value
 - all of the above
- A secondary optical property is ____.**
 - chroma
 - surface gloss
 - iridescence
 - both b and c
- Both dentin and enamel are translucent in natural teeth. The enamel layer is opaque and imparts all of the colors of a tooth.**
 - The first sentence is true and the second sentence is false.
 - The first sentence is false and the second sentence is true.
 - Both sentences are true.
 - Both sentences are false.
- Which property produces a rainbow effect within the object being viewed?**
 - surface gloss
 - fluorescence
 - opalescence
 - iridescence
- Both enamel and dentin fluoresce. The combination of these structures can enhance the whiteness or value of teeth.**
 - The first sentence is true and the second sentence is false.
 - The first sentence is false and the second sentence is true.
 - Both sentences are true.
 - Both sentences are false.

Answer Sheet for Test 105.#

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Please evaluate this month's article.

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Test 105.#

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