Composite Restorations: Subtleties in Shade and Technique

A Peer-Reviewed Publication
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Educational Objectives
The overall goal of this article is to provide dental professionals with information on composite esthetics, physical strength and chairside technique. Upon completion of this course, the clinician will be able to do the following:
1. List and describe the influence of dental anatomy and the physics of light on color/shade of the natural dentition and esthetic restorations
2. List and describe the influence of light and other operatory factors on perceived shades
3. List and describe the methodology for shade taking for composite restorations
4. List and describe the physical attributes that are important in composite restorations, and which are relevant for anterior and posterior restorations respectively
5. Describe the chairside techniques that can be used for composite resin placement and methods for their simplification

Abstract
The esthetics, strength and longevity of composite restorations are prime considerations for clinicians and patients. In order to select a composite shade and chairside technique, an understanding of the influence of dental anatomy and light on color/shade is necessary, as is knowledge of the desired physical attributes and technique options available. Current composites offer reliable esthetic solutions, improved physical attributes and simplified solutions.

Introduction
The demand for esthetic anterior and posterior restorations is a key factor in the placement, and popularity with patients, of direct composite and indirect composite/ceramic restorations. Anterior direct restorations in the esthetic zone must match the tooth in fine detail as well as possess suitable physical characteristics and sufficient strength for function. For posterior esthetic direct restorations, shade match with the tooth is still important, but there are greater requirements for physical characteristics and strength due to the potential size and volume of some restorations as well as the stress-bearing nature of the posterior dentition.

The most commonly placed esthetic direct restorative materials are composite resins. The first composites were hand-mixed, self-cured dual paste systems (base and catalyst) that required rapid placement. By the 1990s, light-cured composite resins had already evolved such that satisfactory anterior and stronger posterior composite resin restorations were possible. Since then, improved chemistry, the use of fillers, and an increased understanding of the role of light and particle fillers in composites have resulted in the availability of highly esthetic, physically superior composites. An additional goal has been simplification of the chairside technique and steps involved, without sacrificing desirable physical and visible attributes. In the selection of direct restorative materials, function, ease of chairside use, simplicity and esthetics are all considerations. These in turn are dictated by the surrounding dental anatomy and the influence of light.

Esthetics
The Influence of Dental Anatomy
Dental anatomy and contour influence the color of the teeth and esthetic restorations. The natural tooth’s shade varies with the age of the patient, region of the tooth, and whether enamel and/or dentin is exposed. Age-related changes occur in the enamel and dentin (as well as the pulp) during an individual’s lifetime.2 In younger patients, enamel and dentin are thicker, and more opaque and less translucent, in the incisal area. In newly erupted permanent incisors, the mamelons are present and result in a dense, slightly darker, yellowish area at the incisal edges in some patients. This effect is due to counter-opalescence at the mamelons.2 As the patient ages, the mamelons are first ground down until the incisal edge is smooth (unless malocclusion precludes this from happening) and the incisal third gradually takes on a more translucent appearance. Dentin gives teeth a more opaque (dense) appearance than enamel. By the time a patient reaches middle age or later, a significant grey translucent area is typically present incisally as the dentin recedes and the enamel thins. Older patients typically exhibit a larger area of translucency at the incisal third and a darker, more opaque area in the cervical third of teeth.3 Significant differences have been found in color distribution and translucency/opacity of teeth from the incisal third to the gingival third in all age groups. The deepest colored areas are found cervically and on the canine teeth. In addition, natural teeth with smooth surfaces and a relatively uniform, healthy level of mineralization will appear respectively lighter than those with rough surfaces and more even in shade than those with variable degrees of mineralization. Age and anatomic differences are factors in choosing a technique, composite material and shades.

Figure 1. Incisors with mamelons and dense appearance in a young patient
The physics of light is responsible for the perceived color/shade of teeth and restorations. Light absorption and transmission, diffusion, refraction, reflection, and scattering all play a role. The three main considerations in color (shade) are based on the system developed by Munsell at the beginning of the twentieth century. These are the hue, chroma and value of an object or material. The hue is what we would typically think of as “color” and is dictated by the wavelength of light. The chroma is the degree of saturation or purity of that hue (what would typically be thought of as the intensity or concentration of the color). Chroma has been found to increase with age in both enamel and dentin, while hue and value do not, based on in vitro testing. Lastly, the value is the degree of lightness or darkness of the color or material and is dictated by the transmission of light through, and reflectance of light from, the material. Value ranges from black (value 0) to white (value 10) under the Munsell system. The degree of light transmission determines the translucency, with greater transmission resulting in greater translucency; the degree of light scattering influences the opalescence and lifelike appearance of the teeth or restorations; the degree of light absorption influences the opacity; and the degree of fluorescence influences the degree to which a material can absorb UV light and show it as visible light. All are characteristics that in a selected composite must be compatible with the adjacent dentition.

The importance of shade selection and esthetics is underscored by the increasing number of shades and composite techniques available, as well as the increased focus on teaching the scientific basis for color and shade selection in dental schools. In a recent study of dental schools globally (130 responses, slightly over half from North America), it was found that tooth color, factors responsible for color, shade matching and whitening were widely taught and that the most commonly used shade guides were the Vitapan Classical (Vita) and the Vitapan 3D-Master.

The influence of light on the perception of color and esthetics
The type of light under which color/shade is viewed or judged influences the perception of color/shade. In fact, observing the same material/object under different light conditions can alter the perceived color in some materials – this phenomenon, metamerism, results in a shade looking different due to differences in how the type of light is absorbed and reflected from that object or material. It is essential to understand the influence of light for accurate shade taking for esthetic restorations.

Composite Resin, Shade Selection and Shade Guides
Composite resin restorations must match the surrounding dentition for hue, chroma, value, translucency, opacity, fluorescence and opalescence. This can be achieved with one or several shades, depending on the composite system. Irrespective of this, the same shade selection and light physics principles apply, with the difference being whether this must be repeated for several shades that will blend or whether one shade can be found that meets all requirements and blends in with the surrounding dentition.

Translucency and opacity (the opposite of translucency) are important concepts for shade selection. If a shade is selected that does not mimic the translucency and opacity of the tooth, it will be obvious and not blend in. In general, thinner layers are more translucent. The ability of composite materials at a given thickness to provide opacity and translucency varies, some requiring a greater thickness than others to block out dark objects such as the oral cavity behind the teeth and a lesser thickness for translucency, such as would be required at incisal and proximo-incisal areas. Without opalescence, the composite resin will appear dull. Opalescence matching that of natural teeth is possible with composite resins. In fact, one study found the opalescence of tested direct composite resins to be more tooth-like than that of indirect composite materials or ceramics. Fluorescence is also important – the composite resin must have fluorescence similar to that of the natural tooth to be undetectable. In vitro testing has found considerable variation in the fluorescence of commercially available composites, highlighting the importance of assessing and investigating all visual characteristics before choosing a composite.

Another consideration for composite resins is goniochromism, i.e., the ability for its color to be perceived differently depending on the angle
A shade must mimic the translucency and opacity of the tooth in order to be able to blend in.

The components of composite materials should also be considered. The three basic types of composites – microfilled, nanofilled and hybrid – differ in their ability to provide esthetics. Filler content influences esthetics; microfilled and nanofilled composites contain microscopic filler particles that scatter light, whereas hybrid resins are less esthetic. Light-scattering is also influenced by the shape of the filler particles – multifaceted particles scatter and reflect light in different directions, and nanofilled composites transmit light more than other composites. Both nanofilled and hybrid composites have been found to meet the physical requirements for stress-bearing areas. One study found that at the end of two years, hybrid composite restorations demonstrated better margins with lower leakage, staining and discoloration than microfilled restorations. While microfilled resins may initially be esthetically pleasing, they are in general not as strong as nanofilled and hybrid (or microhybrid) composites – an important consideration for Class I, II and IV restorations. Nanocomposites have been found to provide satisfactory strength and esthetics and high polishability, including for Class IV restorations in the anterior esthetic zone.

Light-scattering is influenced by the presence, as well as the shape, of filler particles.

Accurate Shade Taking
Accurate shade taking is best accomplished using natural daylight; a second source of light should also be used to see if the shade matches under both light conditions. This can also help avoid the problem of metamerism. Natural daylight also varies by time of day and direction, thereby altering perception when shade matching (with light at the middle of the day and from a northerly direction considered to be ideal). Another option is the use of a light-correcting device, which was found in a recent study among 216 dental students to result in greater shade accuracy than natural daylight alone, with no statistical differences in results between males and females or first-year versus more-advanced students. Use of the light-correcting device resulted in lower accuracy with Vita C shades compared to other shades in both natural light and using the light-correcting device. Squinting while choosing value helps to reduce the amount of light reaching the eye and improves accuracy. Operatory lights should not be used for shade taking and could result in an incorrect shade choice. The surrounding colors also influence the perception of shade/color – for instance, shade selection should never be conducted while a patient is wearing lipstick as this would interfere with the perceived shade and result in a poor choice. Bright or dazzling colored clothing or surroundings will also interfere with shade selection, hence the recommendation that the operatory have neutral-colored walls, floor covering and upholstery. Finally, different people perceive color differently – ranging from normal to varying degrees of color blindness. The five primary colors in the Munsell hue range are red, green, blue, yellow and purple. Shade taking is only accurate if the shade taker perceives these colors normally and has no color vision abnormality (typically, red-green color blindness, although other variants are also possible).

Table 1. Hints for Shade Selection

<table>
<thead>
<tr>
<th>Hints for Shade Selection</th>
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<tbody>
<tr>
<td>Ask patient to remove lipstick</td>
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<tr>
<td>Place a light blue/grey/white bib over the patient’s clothing</td>
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<td>Select shades at the start of the appointment and before prep-</td>
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<td>ping the tooth</td>
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<tr>
<td>Select shades after removal of any significant extrinsic stain</td>
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<td>on the adjacent dentition</td>
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<tr>
<td>Place the shade guide tab at arm’s length from your eyes</td>
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<td>Place the shade guide tab alongside the patient’s surrounding</td>
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<td>dentition</td>
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<td>Look for only a few seconds at a time to avoid eye fatigue</td>
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<tr>
<td>that would influence shade selection</td>
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<tr>
<td>Use the shade guide recommended by the composite manufacturer</td>
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<tr>
<td>Use the shade guide in a systematic manner to select hue,</td>
</tr>
<tr>
<td>chroma and value</td>
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<tr>
<td>Consider the light source – natural daylight is best</td>
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<tr>
<td>Use more than one source of light</td>
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<tr>
<td>Ensure that the shade taker has been tested for color blindness</td>
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<td>and has no such abnormality</td>
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Shade Guides
Some composite systems require the use of custom shade guides, rather than the commonly used Vitapan Classical (Vita) shade guide or Vitapan 3D-Master shade guide. Recently introduced shade guides include the Vita Valueguide 3D-Master and a digital device. When using a composite system, the recommended shade guide must be used to ensure the best match possible in the final, polymerized composite compared to the surrounding dentition (or other restorations). In addition, be sure that if a stock shade guide is recommended that this in fact does match the shades of the cured composite, as this is not uniformly the case. It is also worth noting that mixing and matching shades from different composite systems is ill-advised – different composite systems have variable shades for a given Vita shade classification with potentially low levels of color congruence (e.g., two B3 shades can differ).
composite shade should not be selected by placing a layer of uncured composite resin against the teeth or against the shade guide, since the composite will change after curing. On occasion it may be useful to place a very thin layer on the tooth and cure it to view before easily removing it, provided no etching or bonding preceded this. The composite material must also be color stable to avoid compromised esthetics over time.25 When performing shade selection, first the hue, then the chroma and then the value are chosen. If using a Vitapan shade guide, this order will result first in choosing from A-D for the hue, then selecting from within that group for the chroma. Lastly, the value is selected based on degree of lightness/darkness and may result in a different shade being viewed as an alternative.

Figure 3. Vitapan Classical shade guide

Note that with the increase in the number of patients who have had tooth whitening, many composite systems now offer two or three bleaching shades – in the case of patients who regularly and heavily whiten their teeth, the bleaching shades will probably be the best (and sometimes only) place to start.

When using a composite resin, the manufacturer’s recommended shade guide must be used to ensure the best match possible of the restoration with the teeth.

Physical Attributes
Key physical attributes for a composite resin include its compressive strength, flexural strength, modulus of elasticity, resistance to shrinkage, surface hardness, wear resistance and low porosity. These impact the strength of the material and its longevity and are important for anterior and posterior restorations, with compressive strength and wear resistance being particularly important in posterior stress-bearing areas. The ability to achieve a high polish, as well as stain resistance, wear resistance and low porosity, are essential for initial and long-term esthetics. A high polish results in a smooth surface that not only feels better to the patient but also reflects and scatters light well for an optimal appearance (and prevents incremental plaque buildup on rough surfaces). Radiopacity is also important to enable visualization of restorations on radiographs, and, of course, materials should be biocompatible. Key handling characteristics are the handling time, setting time and stickiness of the material, as well as the ability to pack it (particularly for posterior restorations), sculpt it and polish it to a fine gloss. All the above must be considered in an optimal blend of physical attributes available in the chosen composite.

Simplification
Considerable effort has been made to provide simpler, reliable techniques with esthetics and strength for clinician and patient acceptance.

Adhesive Systems
Bonding systems have become simpler to use and with reduced chairside time. This has resulted in the development of self-etch bonding systems that will etch and bond in one step versus the separate etching, rinsing, drying and bonding steps of traditional etch-and-bond systems (three-step and two-step bonding systems). The choice of adhesive agent (number of steps/technique) depends on the situation and the composite. Many composite systems have an accompanying bonding system that must be used with that system – if the manufacturer recommends a custom bonding system, this must be used for reliable results, as the chemistry of the composite may be incompatible with generic bonding systems.
Esthetic Cases

Increasingly, patients are demanding highly esthetic direct restorations. Options available to the clinician include single shade, layering techniques, tinted composites and extrinsic stains that can be placed over composites. Multiple shades, tinting and mixing of composite materials may be required for esthetically more difficult cases, such as restorations adjacent to areas of hypocalcification or certain Class IV restorations. Paint-on, extrinsic composite stains are also available, although infrequently used. The majority of composite systems offer multiple shades, many with shades for mature patients as well as bleaching shades. The blending of layered composite resin restorations also varies by the specifics of the composite system selected, further complicating clinical choice. For simplicity, much of the recent focus has been on the development of composite shades that can be used for single-shade restorations that mimic, and are indiscernible from, the surrounding dentition. Single-shade restorations are simpler to place and less technique-sensitive (in both shade selection and placement) and can reduce chairside time for the patient and clinician.

One of the most difficult cases to treat with direct composites is the Class IV, requiring the material to mimic both dentin and enamel, with an incisal edge that must possess the characteristics of the natural adjacent incisal edge and a final thickness, contour and surface texture that matches the tooth and adjacent teeth. Higher strength is also required than with other anterior composite restorations. Methods used to treat these challenging cases include the use of multiple layers of several shades of composites.

Nanocomposites have been found to provide satisfactory strength and esthetics and high polishability, including for Class IV restorations in the anterior esthetic zone.

Delivery

The delivery and placement of composite resins have been improved through the use of several technologies and, since the early days of hand-mixing, several options have become available.

The use of light-cured composites removes the need for mixing a base and catalyst. Delivery vehicles now include syringes and single-unit doses. Single-unit doses can be extruded onto a pad, or the composite can be placed directly into the preparation using a syringe/gun loaded with the unit dose. With good access, this can be an attractive option, and single-unit doses used properly aid infection control (note that the syringe/gun must still be handled in accordance with infection control regulations). In some cases with extra-large restorations, two rather than one disposable single-unit would be required. With syringes, if a measured amount of composite is extruded onto the pad (i.e., sufficient for the preparation but not excessive), then composite waste can be reduced and there is no need to dispose of unit doses. The extruded amount can be varied depending on the size of the preparation. The amount of force required and handling of syringes vary. Ideally, the required force should be small but sufficient to avoid excessive or sudden extrusion. A new syringe design offers visual and click measurements for the extrusion of 0.1 g “unit dose” increments of composite as required for the restoration. Syringes must also be handled in accordance with infection control regulations. The selection of syringes and guns should consider the force required to inject or apply the material contained in the syringe or unit dose as well as the shape and texture of the applicator. Currently available options vary in the pressure that needs to be applied with the thumb and/or finger, and shapes of applicators on composite syringes vary from small to large, round to square and textured or non-textured. A recently introduced applicator has a flat, cushioned end to help avoid thumb pressure or discomfort.
Chairside Technique and Considerations

Chairside technique is determined by the requirements of the specific restoration and from there the composite materials to be used. Esthetic demands, particularly in the case of anterior restorations where these are paramount, suggest the use of nanofilled or microfilled composites, while demands for high physical strength suggest the use of either a nanofilled or hybrid composite. Class I, II and IV restorations all require greater strength than other restorations, and Class IV restorations are perhaps the most challenging to perform and achieve beautiful restorations with single or multiple shades (multiple shades may be required for the most difficult cases even with the more recent composites). The case below demonstrates the use of a simplified single-shade technique for a Class IV restoration using a new nanofilled composite restorative material and delivery system (Nuance, Discus Dental).

Case Study

The patient was concerned about his lower right lateral incisor, which was fractured at the incisal corner. It was determined in consultation with the patient that the best option was a direct bonded composite restoration.

After the area was rendered free of debris and stain, the Universal shade was selected using the standard Vita shade guide. The enamel at the margins was then etched, rinsed and dried, and the fractured area and enamel margins then received an application of self-etch adhesive (Moxie SE, Discus Dental). Some clinicians prefer to etch the enamel margins, as well as using self-etch adhesive, to provide for additional adhesion. This was followed by extrusion of 0.1 g of the selected shade onto a mixing pad and placement of the material into the incisal area using a composite instrument.

This composite was then sculpted prior to light-curing it. Finishing and polishing was achieved using a fine finishing bur and polishing bur to achieve a high gloss, which was aided by the microscopic nanofillers. As can be seen from the clinical image, the result was an esthetic restoration that blended with the surrounding tooth and matched it for translucency and opacity as well as other characteristics. The material is able to scatter and refract light from many angles due to the multifaceted nature of the nanofillers and to reflect light similarly to the surrounding dentition. This single-shade technique is simplified compared to use of multiple shades and layering, and reduces chairside time without compromising results.

Figure 8. Lower right lateral incisor with etched Class IV preparation

Figure 9. Placement of bonding agent

Figure 10. Light-curing of bonding agent

Figure 11. Class IV restoration during light-curing

Figure 12. Class IV restoration after light-curing
Summary

Composite resin restorations now offer reliable, esthetic results, with relative strength and esthetic result depending on the type of composite (nanofilled/microfilled/hybrid) and the specific composite used. It is paramount that shade taking be optimized and a composite selected that fits the desired chairside technique. Recent composites enable the use of single-shade techniques for most restorations, including more challenging cases, reducing chairside time while achieving clinically excellent results.

Glossary of Terms

Chroma: The actual color of a material
Fluorescence: The ability of a material to absorb UV light and produce light that is visible to the naked eye
Goniochromatism: The ability of a material to appear to be different colors, depending on the angle from which it is observed
Hue: The degree of intensity of the hue (saturation/concentration)
Mamelons: The three protrusions on the incisal edge of an incisor that has just erupted
Metamerism: The ability of a material to appear to be different colors under different types of light conditions
Opacity: The ability of a material to appear dense and to block objects and colors showing through from behind the material
Opalescence: The ability of a material to exhibit a shimmer or a milky appearance
Translucency: The ability of a material to permit the transmission of light through it
Value: The degree of lightness/darkness of a material

References

22. Browning WD, Contreras-Bulnes R, Brackett MG, Brackett WW. Color differences: polymerized composite and


### Questions

1. Anterior direct restorations in the esthetic zone must
   a. match the tooth in fine detail
   b. possess suitable physical characteristics
   c. possess sufficient strength
   d. all of the above

2. The most commonly placed esthetic direct restoratives are ________.
   a. veneers
   b. composite resins
   c. amalgams
   d. none of the above

3. The natural tooth’s shade varies with
   a. whether enamel and/or dentin is exposed
   b. the region of the tooth
   c. the age of the patient
   d. all of the above

4. In younger patients, enamel and dentin are ________ in the ________ area.
   a. more opaque and less translucent; cervical
   b. less opaque and more translucent; cervical
   c. more opaque and less translucent; incisal
   d. less opaque and more translucent; incisal

5. In newly erupted permanent incisors, the ________ result in a slightly darker, yellowish area at the incisal edges.
   a. enamels
   b. maneloms
   c. maneloms
   d. none of the above

6. The deepest colored areas are found ________.
   a. incisally
   b. proximally
   c. cervicaly
   d. all of the above

7. Natural teeth with smooth surfaces will appear ________ than those with rough surfaces.
   a. darker
   b. yellower
   c. lighter
   d. none of the above

8. The three main considerations in color (shade) are based on the system developed by ________.
   a. Munsell
   b. Musella
   c. Munsell
   d. Montell

9. The hue is dictated by the ________.
   a. surroundings
   b. wavelength of light
   c. speed of light
   d. transmittory factors

10. The value is ________.
   a. degree of lightness or darkness
   b. dictated by the transmission of light
   c. dictated by the reflectance of light
   d. all of the above

11. The degree of light transmission determines the ________.
   a. translucency
   b. radioluency
   c. transparency
   d. all of the above

12. The degree of light scattering influences ________.
   a. Opacity
   b. Opalescence
   c. Translucency
   d. all of the above

### Author Profile

Dr. Robert A. Lowe received his Doctor of Dental Surgery degree, magna cum laude, from Loyola University School of Dentistry in 1982. Following graduation, he completed a one year Dental Residency. Dr. Lowe taught Restorative and Rehabilitative Dentistry for 10 years at Loyola University School of Dentistry in Chicago, IL. Dr. Lowe has maintained a full-time private dental practice for 26 years. He is a member of the American Dental Association, a sustaining member of the American Academy of Cosmetic Dentistry, and a member of the American Society of Dental Aesthetics. Dr. Lowe has received Fellowships in the Academy of General Dentistry, International College of Dentists, Academy of Dentistry International, Pierre Fauchard Academy, American College of Dentists, and the International Academy of Dento-Facial Aesthetics. In 2004, Dr. Lowe received the Gordon Christensen Outstanding Lecturer Award for his contributions in the area of Dental Education. In 2005, he received Diplomate status on the American Board of Aesthetic Dentistry. Dr. Lowe has authored several hundred articles in many phases of cosmetic and rehabilitative dentistry, sits on the editorial board of several dental publications, and has contributed to dental textbooks. He is a consultant for a number of dental manufacturers world wide and is active as a key opinion leader in the development of new materials and techniques.

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Questions

13. The degree of fluorescence influences the degree to which a material can ________ UV light.
   a. deflect
   b. adsorb
   c. absorb
   d. all of the above

14. The phenomenon ________ results in a shade looking different due to differences in how the type of light is absorbed and then reflected from that object or material.
   a. metamerism
   b. metameratism
   c. goniochromism
   d. none of the above

15. The ability of composite materials at a given thickness to provide opacity and translucency ________.
   a. is constant
   b. varies
   c. depends on the amount of zinc they contain
   d. b and c

16. One study found the opalescence of tested direct composite resins to be ________ tooth-like than that of indirect composite materials or ceramics.
   a. less
   b. darker and more
   c. more
   d. none of the above

17. Goniochromism is the ability for a material’s color to be perceived ________.
   a. identically from all angles
   b. differently from different angles
   c. differently in different lighting
   d. any of the above

18. Microfilled and nanofilled composites contain ________ filler particles that ________ light.
   a. macroscopic; adsorb
   b. microscopic; absorb
   c. microscopic; scatter
   d. macroscopic; scatter

19. Accurate shade taking is best accomplished using ________.
   a. operator lighting
   b. natural daylight
   c. artificial lighting
   d. any of the above

20. Squinting while choosing ________ helps to reduce the amount of light reaching the eye and improves accuracy.
   a. chroma
   b. hue
   c. value
   d. all of the above

21. ________ will interfere with shade selection.
   a. bright colored clothing
   b. lipstick
   c. striking wall colors
   d. all of the above

22. A shade should be selected ________.
   a. after prepping the tooth
   b. at the start of the appointment
   c. after removal of intrinsic stain
   d. all of the above

23. The shade guide tab should be placed ________.
   a. at elbow level
   b. at arm’s length from your waist
   c. at arm’s length from your eyes
   d. at nose level

24. When selecting a shade, the operator should look for only a few seconds at a time to avoid ________.
   a. eye fatigue
   b. arm fatigue
   c. accentuation
   d. all of the above

25. Mixing and matching shades from different composite systems is ________.
   a. acceptable
   b. ill-advised
   c. advised
   d. none of the above

26. When performing shade selection, the ________.
   a. value is always selected first
   b. hue is always selected last
   c. hue is selected first
   d. transparency is selected first

27. In the case of patients who regularly and heavily whiten their teeth, the ________ will probably be the best place to start.
   a. Vita A shades
   b. Vita B shades
   c. cervical shades
   d. bleaching shades

28. ________ are particularly important in ________ areas.
   a. Flexural strength and wind resistance; posterior non-stress-bearing
   b. Flexural strength and wear resistance; posterior stress-bearing
   c. Compressive strength and wear resistance; anterior non-stress-bearing areas
   d. Compressive strength and wear resistance; posterior stress-bearing

29. A high polish results in a smooth surface that ________.
   a. feels better to the patient
   b. reflects and scatters light well
   c. prevents incremental plaque buildup on rough surfaces
   d. all of the above

30. Radiopacity is important to ________.
   a. improve translucency
   b. enable visualization of restorations on radiographs
   c. increase opacity
   d. b and c

31. The ability to pack composite resins is particularly important for ________.
   a. anterior restorations
   b. posterior restorations
   c. tunnel restorations
   d. all of the above

32. Self-etch bonding systems will etch and bond in ________.
   a. one step
   b. two steps
   c. three steps
   d. all of the above

33. ________ is an option available to the clinician for esthetic restorations.
   a. A single shade technique
   b. A multilayering technique
   c. A tinted composite
   d. all of the above

34. Paint-on, extrinsic composite stains are ________.
   a. frequently used
   b. infrequently used
   c. not esthetically pleasing
   d. all of the above

35. A recent focus has been the development of composite shades that can be used for ________ restorations.
   a. single-shade
   b. triple-shade
   c. grey shade
   d. all of the above

36. Single-shade restorations ________.
   a. are simpler to place
   b. are less technique-sensitive
   c. can reduce chairside time
   d. all of the above

37. One of the most difficult cases to treat with direct composites is the ________.
   a. Class I
   b. Class IV
c. Class VI
d. none of the above

38. ________ is required for Class IV restorations than with other anterior composite restorations.
   a. Lower strength
   b. Higher strength
   c. Lower wear resistance
   d. none of the above

39. Delivery vehicles now include ________.
   a. syringes
   b. rinse mixes
   c. single-unit doses
   d. a and c

40. Single-unit doses used properly aid ________.
   a. operator control
   b. infection control
   c. patient control
   d. all of the above

41. With syringes, if a measured amount of composite is extruded onto the pad ________.
   a. composite waste can be reduced
   b. there is no need to dispose of unit doses
   c. there is no need to dispose of syringes when empty
   d. a and b

42. The amount of force required and handling of syringes ________.
   a. are the same
   b. vary
   c. is immaterial
   d. a and c

43. The selection of syringes and guns should consider ________.
   a. the force required to inject the material
   b. the shape of the applicator
   c. the texture of the applicator
   d. all of the above

44. Demands for high physical strength suggest the use of ________.
   a. a hybrid composite
   b. a nanofilled composite
c. a macrofilled composite
   d. a or b

45. Esthetic demands suggest the use of ________ composites.
   a. nanofilled or hybrid
   b. hybrid or microfilled
c. nanofilled or microfilled
   d. nanofilled or macrofilled
Composite Restorations: Subtleties in Shade and Technique

Name: ___________________________ Title: ___________________________ Specialty: ___________________________

Address: ___________________________ E-mail: ___________________________ 

City: ___________________________ State: ___________________________ ZIP: ___________________________ Country: ___________________________

Telephone: Home (________) Office (________) Lic. Renewal Date: ___________________________

Requirements for successful completion of the course and to obtain dental continuing education credits: 1) Read the entire course. 2) Complete all information above. 3) Complete answer sheets in either pen or pencil. 4) Mark only one answer for each question. 5) A score of 70% on this test will earn you 3 CE credits. 6) Complete the Course Evaluation below. 7) Make check payable to PennWell Corp. For Questions Call 216.398.7822

Educational Objectives

1. List and describe the influence of dental anatomy and the physics of light on color/shade of the natural dentition and esthetic restorations
2. List and describe the influence of light and other operatory factors on perceived shades
3. List and describe the methodology for shade taking for composite restorations.
4. List and describe the physical attributes that are important in composite restorations, and which are relevant for anterior and posterior restorations, respectively
5. Describe the chairside techniques that can be used for composite resin placement and methods for their simplification

Course Evaluation

Please evaluate this course by responding to the following statements, using a scale of Excellent = 5 to Poor = 0.

1. Were the individual course objectives met?  
   Objective #1: Yes No  
   Objective #2: Yes No  
   Objective #3: Yes No  
   Objective #4: Yes No

2. To what extent were the course objectives accomplished overall?  
   S 4 3 2 1 0

3. Please rate your personal mastery of the course objectives.  
   S 4 3 2 1 0

4. How would you rate the author's grasp of the topic?   5 4 3 2 1 0

5. How do you rate the author's grasp of the topic?   5 4 3 2 1 0

6. Please rate the instructor's effectiveness.  5 4 3 2 1 0

7. Was the overall administration of the course effective?  
   S 4 3 2 1 0

8. Do you feel that the references were adequate?    Yes  No

9. Would you participate in a similar program on a different topic?  
   Yes  No

10. If any of the continuing education questions were unclear or ambiguous, please list them.

   __________________________________________
   __________________________________________
   __________________________________________
   __________________________________________
   __________________________________________

11. Was there any subject matter you found confusing? Please describe.

   __________________________________________
   __________________________________________
   __________________________________________
   __________________________________________
   __________________________________________

12. What additional continuing dental education topics would you like to see?

   __________________________________________
   __________________________________________

If not taking online, mail completed answer sheet to Academy of Dental Therapeutics and Stomatology, A Division of PennWell Corp., P.O. Box 116, Chesterland, OH 44026 or fax to: (440) 845-3447

   PLEASE PHOTOCOPY ANSWER SHEET FOR ADDITIONAL PARTICIPANTS.

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