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Composite Restoration Esthetics
A Peer-Reviewed Publication
Written by Robert C. Margeas, DDS, FAGD

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Educational Objectives
Overall goal: The purpose of this article is to provide dental professionals with information about the aesthetic considerations and strength of direct composites. Upon completion of this course, the clinician will be able to do the following:
1. Know the categories of composite resin restorative materials available and their characteristics and indications for use.
2. Know the modes of failure for composite resin restorative materials.
3. Know the shade considerations involved in the attainment of esthetics in composite resin restorations and the use of different shading and layering techniques.
4. Know the relevance of a smooth surface and gloss as well as polishability, and factors influencing these.

Abstract
The increased use of direct composite restorations can be mainly attributed to patient demand for esthetic restorations and the availability of composites with high strength and excellent esthetics. While early composites were weak and suitable only for anterior restorations, current composites are highly esthetic and offer high strength for their intended purposes. Techniques have also evolved, with sophisticated bonding techniques and single-shade, dual-shade, and multilayering techniques to optimize esthetics. It is important to consider not only the individual case, relative strength, and esthetics of different types of composites but also the technique to be used when selecting a restorative material.

Introduction
Direct composite restorative materials offer esthetic solutions for clinicians and patients. Esthetic solutions must be achieved in tandem with the functional requirements of strength, volumetric and morphologic stability, physical compatibility with the surrounding tooth structure, biocompatibility, and the ability either to self-adhere to the tooth surface or to adhere with an adhesive system for a durable bond at the tooth-restoration interface. Additional desirable properties include the ability to inhibit biofilm formation, thereby reducing the load of acidogenic and periodontal bacteria; stain resistance; and user-friendliness. Ideally, a restorative material will meet all these requirements, allowing it to be used for both anterior and posterior restorations. While amalgam fulfills the physical requirements for direct restorations, is quicker and easier to place than are esthetic restorative materials, is more tolerant of moisture, and can now be hybrid-bonded with the use of amalgam bonding techniques (which has reduced the need for classical amalgam preparations, although results have been found to be variable), its lack of aesthetic results means it is suitable only for posterior restorations. Its use for posterior restorations has also gradually declined as patients have become increasingly aware of esthetics and want the improved posterior esthetic materials that have become available in response to these demands. Clinicians demand esthetic materials with improved physical and handling properties. Physical requirements differ for anterior and posterior restorations. Anterior restorations, especially those involving incisal edges, require high strength as well as high esthetics. Posterior restorations have the added requirement of low wear. Esthetic restorative materials must offer adequate shade availability, suitable chroma and values, translucency, opacity, opalescence, fluorescence, a smooth and glossy surface, and stain and wear resistance.

Development of Composite Resins
When first introduced in the 1970s, composite resins were utilized only for anterior restorations. These early variants were typically quartz-filled; did not meet the compressive and tensile force requirements for posterior restorations; and had relatively high surface roughness, low polishability, poor resistance to staining, and poor bonding at the tooth-restoration interface, which, in combination with polymerization shrinkage, resulted in margin degradation and postoperative sensitivity. The choice of shades was limited, and the materials, other than being tooth-colored, offered poor esthetics with little or no differentiation of shading by fluorescence, translucency, or intended location (such as cervical shades for cervical restorations). In addition to these disadvantages, early resin composites were difficult to handle, required manual mixing of the resin paste (A) and the catalyst (B), were available only in tubs or syringes of pastes (A and B separately), and were always self-cured with a limited working time. Over time, the strength characteristics of composite resins were improved and the resins were introduced for use in posterior restorations. These materials were still unsuitable for posterior restorations in which high compressive strength was required to resist occlusal and masticatory forces. Wear resistance was also low. Bonding systems were still primitive in the 1980s, with limited choice in technique. Self-adhesive systems were not available and there was little choice in terms of etching methods. The focus was still on enamel etching and bonding, and early attempts at dentin bonding resulted in weak bonding to the smear layer and a rapidly degrading bond. It was also recommended that, after curing of the resin, the enamel-restoration interface be re-etched and an unfilled resin be placed over this surface to seal it and help inhibit microleakage and wear. By the 1990s, posterior composite restorations were available that were better-suited to Class I and Class II restorations. These enabled a more conservative approach during preparation than amalgam did, and they were used with improved bonding systems for improved marginal integrity at the tooth-restoration interface.

Current Composite Restorative Materials
Composite resin materials are currently available as microfilled, (micro)hybrid, and nanofilled composites. Their chemistry is typically based on bisphenol-a-glycidyl dimethacrylate (Bis-GMA); however, additive chemistry has been used to reduce
polymerization shrinkage or stress, and the addition of various sizes and types of fillers has altered physical and esthetic properties. Pre-polymerized clusters and increased filler load help reduce polymerization shrinkage and stress, and increasing filled load also results in a higher viscosity composite. Each composite type offers advantages specific to its chemistry. An understanding of these is necessary to select an appropriate material for clinical procedures.

**Microfilled Composite Resins**
Microfilled composite resins contain crushed particles ranging in size from 0.04 to 1 micron. The filler particles are typically prepolymerized particles comprised of resin and fumed silica. Filler load is lower in microfilled composite resins, and internal bonding between the matrix resin and the prepolymerized filler resin is weak, resulting in lower strength. This is an important consideration in stress-bearing areas. The very small particle sizes in microfilled resins, however, offer excellent esthetics with high polishability and a long-lasting surface gloss.

**Microhybrid/Hybrid Composite Resins**
Microhybrid composite resins contain silicon dioxide filler with particles ranging in size from approximately 0.04 up to 0.1 micron, and glass particle fillers typically in size from 0.4 to 0.6 micron (400 to 600 nm). These resins lose their high polish over time with the development of a rougher surface, reducing their suitability for esthetically demanding cases. They do, however, offer strong physical properties and are suitable for stress-bearing restorations. Hybrid resins have slightly larger filler sizes than do microhybrid resins and essentially behave in the same manner.

**Nanofilled Composite Resins**
Nanofilled composite resins have a high filler load in order to obtain strength and wear resistance similar to that of microhybrid composite resins. Nanofilled composite resins contain smaller particles of filler in the range of 0.02 to 0.1 microns. One nanofilled composite (Filtek Supreme Plus) contains nanofiller particles that are approximately 0.02 microns in diameter, sintered into nanoclusters of 0.6 to 1.4 microns that contain zirconia/silica particles, in order to improve physical characteristics.

**Flowable and Packable Composites**
Another method of categorizing composite resin restorative materials is by flow characteristics. Flowable composite resins have a lower filler load and a low viscosity, enabling them to be syringed directly into preparations, where they flow and conform to the preparation margins. The flowable composites are used extensively as a liner under posterior restorations and are also used as an initial bulk layer for the sandwich technique, similar to glass ionomer cements, that is then covered with a microfilled or nanofilled composite. They are also used in clinical situations in which heavy stress-bearing is not a requirement. Packable (universal) composites are denser and can be condensed using plastic instruments during placement, prior to curing. One study comparing a nanofilled composite resin with and without an underlying layer of flowable composite after use of a two-step (total etch) or single-step bonding technique found no statistical differences in secondary caries, postoperative sensitivity, marginal discoloration or adaptation, or color at a two-year recall. Both techniques were found to be clinically successful. Packable composites have been found to be clinically successful over multiple-year analyses.

While clinical function and longevity of esthetic composites are the first prerequisites, optimizing esthetics is desirable and increasingly demanded by patients for all direct composite restorations. Surface smoothness, polishability, luster (surface gloss), and specific shade attributes and techniques all play important roles in the achievement of optimal esthetics.

**Optimizing Esthetics in Composites**
The esthetics of composite restorations is influenced by the shape and contouring of the restoration, which must mimic the natural tooth in order to provide a natural appearance. In the case of posterior restorations, the use of sectional matrices has considerably simplified the achievement of functional and esthetic contours. Beyond the requirements of contour and shaping, and the use of an appropriate technique that avoids moisture contamination and utilizes an appropriate bonding system, esthetics is determined by the availability and appropriate selection of shade(s) – the fluorescence and translucency, value (degree of lightness or darkness), chroma (intensity of the shade), hue, ability to offer a chameleon effect, polishability, wear resistance, retention of gloss and polish, and technique. Each of these plays a role in developing and maintaining optimal esthetics.

**Table 1. Indications for composite resins**

<table>
<thead>
<tr>
<th></th>
<th>High-esthetic restorations</th>
<th>Stress-bearing restorations</th>
</tr>
</thead>
<tbody>
<tr>
<td>Microfilled</td>
<td>X</td>
<td>–</td>
</tr>
<tr>
<td>Microhybrid</td>
<td>–</td>
<td>X</td>
</tr>
<tr>
<td>Nanofilled</td>
<td>X</td>
<td>X</td>
</tr>
</tbody>
</table>

**Table 2. Factors in optimized composite esthetics**

<table>
<thead>
<tr>
<th>Factor</th>
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<tbody>
<tr>
<td>Shape and contour mimicking natural dentition</td>
</tr>
<tr>
<td>Functional and esthetic contours</td>
</tr>
<tr>
<td>Use of an appropriate technique</td>
</tr>
<tr>
<td>Avoidance of moisture contamination</td>
</tr>
<tr>
<td>Use of an appropriate bonding system</td>
</tr>
<tr>
<td>Selection of appropriate shade(s)</td>
</tr>
<tr>
<td>Polishability of the restorative material</td>
</tr>
<tr>
<td>Wear resistance</td>
</tr>
<tr>
<td>Retention of gloss and polish</td>
</tr>
</tbody>
</table>
Shades and Shade Selection

Composite resin systems are available with multiple shades. The number of available shades depends on the brand selected and typically includes a number of shades in the VITA A, B, C, and D ranges to cover the hues, chroma, and values that will be required for natural-looking direct composite restorations. Shades are also available and categorized by translucency and opacity. Regardless of the technique used, if teeth are stained, the staining should be removed prior to selecting a shade(s). Shade selection also should occur prior to placement of a rubber dam, since this will affect perception of color due to color perception interference with the rubber dam and because a desiccated tooth appears whiter than a moist or wet tooth.

Opacity and Translucency

Different shades offer greater or lesser opacity, opalescence, and translucency. Opacity is an important property for composites, offering flexibility by enabling the creation of many shades, ranging from very translucent, which is required for incisal edges and outer multilayering, to highly opaque, which is required for the body of a restoration replacing dentin.12 Opacity is essential for deeper restorations and restorations with a darker pulpal floor/underlying area, in order to prevent shine-through of the floor/underlying area, in order to prevent shine-through of the darkened dentin. In extreme cases, opaquers and tinters may be required.13 Selecting opaque and/or translucent shades can be critical for the esthetic outcome of an individual case,14 and more chromatic shades have been found to be more opaque.15

Controlling the size and volume of filler particles is a contributing factor to light-scattering properties and therefore the perceived color and translucency of composite resins.16 A matching of filler size and resin is essential for light transmission in composite resins and translucency. Translucency increases as the restorative material becomes thinner, irrespective of the shade used – a consideration when using a multilayering technique.17 Filler size in composite resins has been found to influence the transmission and reflection of color, and it results in variations in translucency and opalescence. Opalescence varies with the size and amount of the filler. In general, increased filler load decreases translucency.18 Nanosized filler particles enable the transmission of light, resulting in translucency. Their ability to scatter blue light provides the nanofilled composite with opalescence, which enhances the lifelike appearance of composite resin materials.

Table 3. Influence of filler on esthetics and strength

<table>
<thead>
<tr>
<th>Transmission of light</th>
<th>Reflection of color</th>
<th>Variations in translucency</th>
<th>Variations in opalescence</th>
<th>Low filler is less strong</th>
<th>Viscosity</th>
</tr>
</thead>
</table>

Single-Shade, Dual-Shade, and Multilayering Techniques

From a practical perspective, there is a need for composite resin systems that offer the ability to provide esthetic restorations using only one shade. Single-shade restorations are simpler and quicker to place. Single-shade restorations require that the composite be able to blend in with the surrounding tooth structure through a chameleon effect, such that the gradation from different areas of the tooth’s structure to the restoration is not obvious and results in a natural-looking restoration.

More esthetically demanding clinical situations can require a dual-shade or multilayering technique to mimic the adjacent tooth structure. Dual-shade restorative procedures are suited to situations in which there may be substantial variations in two adjacent areas – for example, for a darker cervical versus coronal area, or for a highly translucent and wide incisal edge versus the more opaque coronal area being restored. When using a dual-shade technique, the dentin color (body of the tooth) should be selected first, followed by the enamel shade (and if a translucent shade is also used, this should be chosen last). Dietschi et al. reported on a shading concept that compared enamel and dentin shades with the opacity and specific color of teeth. After comparing teeth with similar chroma (green-red/blue-yellow values), it was found that only the blue-yellow values varied. Translucency was found to be relatively constant for dentin, and it increased with age in enamel. From these conclusions, a simplified multilayering technique was developed – the “natural layering concept” – that uses a universal dentin hue and one of three enamel hues, depending on the age of the patient (young, adult, and old).19 Multilayering techniques are the most time-consuming and complex, requiring more shades to be used, but they offer the most esthetic solution for specific cases. The blending effect varies with the size of the restoration.20 Advanced layering techniques can also utilize color tints to modify composite shades, such as for the creation of hypocalcification-like areas to mimic adjacent teeth with hypocalcifications where these are not being treated.21

It is important when using dual- or multiple-shade techniques to use the same brand of composite and the shade guide for that composite system. The translucency and shade of composites, while almost universally using the VITA shade guide system for labeling purposes, show variation across brands.22 For multilayering techniques, the blending effect depends on both the specific brand of composite and the shades used.23 Significant differences in color, translucency, and fluorescence have also been found between flowable and packable (universal) composites that were different brands but labeled as the same shades.24 Curing and polishing change the color and translucency of a composite resin, again varying by brand and shade.25,26,21 The shade guide, not uncured resin, should be used for shade selection. Alternatively, recently cured resin can be used.23 It is also important to consider the availability and quality of light within the daylight UV spectrum when selecting shades. As the daylight UV varies, so too does the perceived color of composite resins27 and teeth. The use of computerized
shade guide determination through colorimetric analysis, together with the use of multilayering with nanofilled composites, was found in one study to result in improved esthetics.  

In selecting a composite, sufficient shades should be available in the same brand of composite to satisfy clinical requirements for single-shade, dual-shade, and multilayering techniques. Either an accurate match to the VITA Classical shade guide, or an accurate custom shade guide must be available for the selected composite’s shade system.

Table 4. Tips for Multilayering Techniques

- Use the same brand of composite for all layers
- Ensure the amount and quality of daylight is adequate for shade selection
- Do not use uncured resin to determine shades
- Use the VITA shade guide if the composite system accurately mimics this
- Use a custom shade guide if the composite system has custom shade labeling

Surface Attributes and Esthetics
Surface smoothness and retention of surface gloss are important for function and esthetics. A high-gloss, smooth surface reflects light, giving a more natural appearance. The scattering and absorption of light on rough surfaces results in a darker, duller appearance. The initial smoothness of composite resins is influenced by the filler particle size and the technique used for polishing and finishing the resin. Composite resins with smaller filler particles are smoother and exhibit greater luster than do larger particle-size filled resins, thus explaining the greater surface smoothness and polish seen in both microfilled and nanofilled composite resins. Nanofilled composite resin containing nanoclusters has been shown to exhibit high translucency, polishability, and gloss, and its long-term polish is comparable to the characteristics of microfilled composite resins. Nanofilled translucent shades retained polish better than did similar microfilled shades. Microhybrids are not as glossy or smooth, but their polishability and esthetics have been enhanced in recent years.

Polishing Composites
Composites can be polished using two-step or one-step systems. These can include the use of silicon tips, Sof-Lex discs, rubber cups, and polishing pastes and liquid polishers. Polishing composites has been found to achieve the greatest improvement in surface gloss within five seconds of polishing. One-step polishing systems are suitable for nanocomposite polishing (Filtek Supreme Plus (or XT outside of US); Grandio; CeramX; Premise; and Tetric EvoCeram) as well as flowable restorative materials; polishing results in a more stain-resistant surface. Surface sealants have been recommended for use following finishing and polishing in order to impart the smoothest surface. It has also been found that removing the outer surface layer during polishing helps stain resistance. The optimal polisher depends on the specific composite.

Table 5. Surface smoothness and polisher

<table>
<thead>
<tr>
<th></th>
<th>Mylar</th>
<th>PoGo</th>
<th>OptraPol</th>
<th>One Gloss</th>
</tr>
</thead>
<tbody>
<tr>
<td>Filtek Supreme Plus</td>
<td>Smoother</td>
<td>Smoother</td>
<td>Rougher</td>
<td>Rougher</td>
</tr>
<tr>
<td>Grandio</td>
<td>Smoother</td>
<td>Smoother</td>
<td>Rougher</td>
<td>Rougher</td>
</tr>
<tr>
<td>Tetric EvoCeram</td>
<td>Less rough</td>
<td>Roughest</td>
<td>Less rough</td>
<td>Less rough</td>
</tr>
<tr>
<td>Premise</td>
<td>No significant differences</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CeramX</td>
<td>No significant differences</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>


It is therefore important to follow the manufacturer’s recommendations for specific composites.

Wear Resistance and Surface Roughness
Over time, surface roughness develops in response to abrasion (as well as acid erosion) of composite surfaces. In vitro three-surface wear testing and simulated cycles of toothbrushing are used to measure the anticipated susceptibility of composite resins to intraoral abrasion from mastication or toothbrushing. In one study, in vitro–simulated toothbrushing resulted in rougher surfaces in microfilled and microhybrid composites than it did in packable composites, compomers, and resin-modified glass ionomers. Polishing composite resins at recall appointments can help to reduce surface roughness that has developed and to impart a smooth surface. Both the amount of surface wear and mechanism of wear over time have been found to differ among resins. Surface roughness is also positively correlated with staining of composites.

Very small particles contained in microfilled resins result in an even wear pattern and thus retention of a smoother surface. The combination of nanofillers around nanoclusters results in removal during wear of the very small nanofilled particles that are packed in the nanocluster surface, again resulting in a more even pattern of wear and a smoother surface. Scanning electron micrographs (SEM) have demonstrated the removal of individual small nanofiller particles from larger zirconia-silica nanoclusters. In contrast, SEMs of microhybrid resins show larger defects at the surface following wear, proposed to be due to the removal of larger individual particles that leave voids and a less even pattern of wear, resulting in a rougher surface than observed with microfilled and nanofilled composites.

Figure 1. Scanning electron micrographs of composite fillers

Courtesy of Dr. Jorge Perdigao
Surface wear results in loss of gloss followed by loss of the layer below the gloss. In vitro data indicates that the microhardness of a nanofilled composite (Filtek Supreme) is higher than that of microfilled composites, attributable to the filler.55

The aging of esthetic restorative materials results in surface changes and therefore changes in the light-scattering absorption properties of glass ionomers, modified glass ionomers, composites, and resin composites.46 Aging of flowable composites has also been found to result in more color changes compared to universal composites.47 Accelerated in vitro aging was found in one in vitro study to result in the loss of translucency but not to affect opacity of composite resins.48

Bacterial Considerations
A smooth, glossy appearance is also important to reduce the potential for bacterial adhesion and the accumulation of biofilm. In vitro studies have found amalgam to be bactericidal and to inhibit the formation of biofilm.59,60 The converse has been found with resin-based restorative materials, although, interestingly, the experimental addition of microparticulate silver to composite resin material has been found in vitro to have a bactericidal effect as well as to inhibit bacterial adhesion.51 These findings increase the importance of selecting a material that both achieves and retains a smooth surface.52 In vitro studies on packable resin composites, compomers (polyacid-modified composite resins), and glass ionomer cements found no antibacterial properties for these materials, while one found a minimal effect for a few days with composite resin.53,54,55,56 In the case of the packable composites tested, newly polymerized resin would actually support the development of biofilm, and one study found that bacteria formed a dense biofilm on composite resin.57,58

Combining Strength and Esthetics
While predictable and reliable esthetics is important, this must not result in compromised functionality. Microfilled resins are highly aesthetic, suitable for anterior restorations in low-stress-bearing restorations. Microhybrid and nanofilled composites are suitable for stress-bearing restorations. Some variability in the mechanical properties of different nanofilled composites has been found in in vitro testing.59

Beun et al. compared the mechanical properties of nanofilled (Filtek Supreme, Grandio, and Grandio Flow), microhybrid, and microfilled composites. The nanofilled composites had an elastic modulus and physical properties at least equivalent or better than those of universal composite and superior to those of microfilled composite.60 One study comparing the properties of nanofilled composite resin containing nanoclusters (Filtek Supreme Universal Restorative) and microfilled and hybrid resin composites found that nanofilled/nanocluster composites offered physical characteristics and strength comparable to those of microhybrid composites. Physical characteristics measured and compared included wear resistance – also a factor in esthetics, compressive and diametral strengths, and fracture resistance.61 The same nanofilled composite was found in other in vitro testing to have higher diametral tensile strength than did microhybrid composites.62

Latest Developments in Composite Resins
Recent developments in composite resin technology have included reductions in polymerization shrinkage and in polymerization stress. These have been achieved through increased filler loads and novel chemical technology. Polymerization shrinkage, and therefore stress, has been reduced through the use of silorane-ring-based chemistry (Filtek LS)63 as well as by increasing conversion rate of the monomer.64 Direct reduction of polymerization stress has now also been achieved through the use of a polymerization modulator to reduce stress (SureFil SDR). A recent development has improved esthetics in a high-strength, esthetic nanofilled composite. Changes in the synthesis of nanoclusters in nanofilled composite resin (Filtek Supreme Ultra) have demonstrated improved polish retention and handling, while maintaining wear resistance, in in vitro testing. The same material has fracture toughness equal to that of the upper range of other composites, as well as high flexural strength.65

The cases below illustrate the use of this new nanofilled/nanocluster composite for single-shade and multilayering techniques.

Case Studies
Case 1. Multi-layering technique
The patient presented with an old, worn and defective composite. After discussion, it was decided to replace the Class IV composite. The old composite was removed, followed by etching of the enamel and dentin, rinsing and drying, then use of the bonding agent. The composite (Filtek™ Supreme Ultra universal composite) was then layered for optimal esthetics, using a thin layer of WE, followed by A1 to create a ‘dentin replacement layer’ at the lobes. This was followed by application of grey translucent shade between the lobes and B1 enamel shade. The final restoration was polished using a Sof-Lex disc, followed by a cup brush and polish for an aesthetic, high gloss smooth surface finish.

Figure 2. Old, worn composite restoration

Figure 3. Old composite removed
Case 2. Single-shade restoration

In this case the patient presented with a carious DO lesion, visible unaided as well as radiographically. The patient preferred an esthetic composite restoration. After removing the carious enamel and dentin, the tooth was first etched, rinsed and dried, and then the adhesive layer applied. Shade A3 body was then used and the composite resin syringed directly into the preparation. The composite was then packed into the tooth and light-cured. Finishing of the restoration was achieved using a fine diamond for fine occlusal contouring, followed first by a Sof-Lex disc and then a brush cup and polish.
Summary

Esthetic composite restorations have gained popularity with patients and increased usage by clinicians. During the development of composite restorations, several categories have been developed. Current composites can be categorized as microfilled, (micro) hybrid, and nanofilled, as well as flowable and packable. Recent developments in composite technology have resulted in improved physical characteristics and improved esthetics, without compromising strength. Each type of composite offers different physical and esthetic characteristics that must be considered when selecting a composite and technique for individual cases.

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Disclaimer
Dr. Margeas has been a speaker on behalf of 3M ESPE as well as other composite manufacturers.

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1. Esthetic solutions for restorations must be achieved in tandem with ____________.
   a. the functional requirements of strength
   b. physical compatibility with the surrounding tooth structure
   c. volumetric and morphologic stability
   d. all of the above

2. The use of amalgam for posterior restorations has gradually increased in recent years.
   a. True
   b. False

3. Early composite resins ____________.
   a. were typically quartz-filled
   b. did not meet the compressive and tensile force requirements for posterior restorations
   c. had high surface roughness and low polishability
   d. all of the above

4. Early posterior composite materials were still unsuitable for posterior restorations in which high compressive strength was required to resist occlusal and masticatory forces.
   a. True
   b. False

5. Composite resin is currently available as ____________ composite.
   a. microfilled
   b. microhybrid
   c. nanofilled
   d. all of the above

6. The addition of various sizes and types of fillers has altered the physical and esthetic properties of composites.
   a. True
   b. False

7. Microfilled composite resins ____________.
   a. contain crushed filler particles, typically prepolymerized and comprised of resin and fumed silica
   b. have a lower filler load than microhybrid composite resins
   c. offer high polishability and excellent esthetics
   d. all of the above

8. Microhybrid composite resins ____________.
   a. develop a rougher surface over time
   b. offer strong physical properties
   c. are suitable for stress-bearing restorations
   d. all of the above

9. Nanofilled composite resins have high filler loads in order to obtain strength and wear resistance similar to that of microhybrid composite resins.
   a. True
   b. False

10. Flowable composite resins ____________.
    a. have lower filler loads than packable composites
    b. flow and conform to the preparation margins
    c. have a high viscosity
    d. a and b

11. One study comparing restorations using nanofilled composite resin with and without an underlying layer of flowable composite found both to be clinically successful.
    a. True
    b. False

12. The value of a composite shade refers to the ____________.
    a. use of hues
    b. degree of lightness or darkness
    c. the opacity of the shade
    d. none of the above

13. Chroma refers to the ____________.
    a. color of a shade
    b. opalescence of a shade
    c. intensity of a shade
    d. none of the above

14. If teeth are stained, the staining should be removed prior to selecting a shade(s).
    a. True
    b. False

15. Selecting a shade while a rubber dam is on the teeth can affect the choice of shade due to the ____________.
    a. altered color perception because of the influence of the rubber dam itself
    b. altered appearance of dessicated teeth
    c. altered number of teeth that are visible
    d. a and b

16. Opacity in a composite ____________.
    a. enables the creation of many shades ranging from opaque to highly translucent
    b. is higher in more chromatic shades
    c. is essential for deeper restorations
    d. all of the above

17. Selecting opaque and/or translucent shades can be critical for the esthetic outcome of an individual case.
    a. True
    b. False

18. The size and volume of filler particles in a composite resin ____________.
    a. contributes to light-scattering properties
    b. influences the perceived color
    c. influences the perceived translucency
    d. all of the above

19. Nanosized filler particles ____________.
    a. enable the transmission of light
    b. scatter blue light
    c. enhance the lifelike appearance of composite resin materials
    d. all of the above

20. In general, increased filler load decreases translucency.
    a. True
    b. False

21. Single-shade restorations ____________.
    a. require that the composite be able to blend in with the surrounding tooth structure
    b. are quicker and simpler to place than dual or multiple shade restorations
    c. are rarely practical
    d. a and b

22. When using a dual shade technique, the dentin color should be selected first, followed by the enamel shade and then, if used, the translucent shade.
    a. True
    b. False

23. Multilayering techniques ____________.
    a. require the most shades
    b. are the most time-consuming and complex
    c. offer the most esthetic solution for specific cases
    d. all of the above

24. It is important when using dual- or multiple-shade techniques to use the same brand of composite and the shade guide for that composite system.
    a. True
    b. False

25. Shade selection for a composite can be determined using ____________.
    a. the shade guide or uncured resin
    b. uncured or cured resin
    c. the shade guide or cured resin
    d. the shade guide for a glass ionomer

26. A high-gloss, smooth surface ____________.
    a. reflects light
    b. results in an appearance that is not as dark or dull as a rough surface
    c. gives a more natural appearance
    d. all of the above

27. The combination of nanofillers around nanoclusters has been shown to result in a more even pattern of wear and a smoother surface.
    a. True
    b. False

28. In vitro data indicates that the microhardness of a nanofilled composite is higher than that of microfilled composites, attributable to the filler.
    a. True
    b. False

29. A smooth, glossy surface can reduce the potential for bacterial adhesion and the accumulation of biofilm.
    a. True
    b. False

30. Each type of composite offers different physical and esthetic characteristics that must be considered when selecting a composite and technique for an individual case.
    a. True
    b. False
ANSWER SHEET
Composite Restoration Esthetics

Name: __________________________ Title: __________________________ Specialty: __________________________

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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 4 CE credits. 6) Complete the Course Evaluation below. 7) Make check payable to PennWell Corp. For Questions Call 216.398.7822

 educational Objectives

1. Know the categories of composite resin restorative materials available and their characteristics and indications for use.
2. Know the modes of failure for composite resin restorative materials.
3. Know the shade considerations involved in the attainment of esthetics in composite resin restorations and the use of different shading and layering techniques.
4. Know the relevance of a smooth surface and gloss as well as polishability, and factors influencing these.

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 objectives and educational methods?  S  4  3  2  1  0

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

6. Please rate the instructor's effectiveness.  S  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.

___________________________________________________________________

___________________________________________________________________

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

___________________________________________________________________

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