

**Anterior Composite Stratification: A Practical Guide**

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**Abstract**

**Aim:** To provide a brief understanding of the characteristics of the dental tissues, and translation of this knowledge to achieve seamless natural direct composite anterior restorations.

**Background:** Direct composite resin restorations have the potential to reproduce the appearance of a natural tooth with highly esthetic outcomes. Such restorations are an economically viable treatment option compared to other indirect approaches. Understanding and knowledge of tooth anatomy, the interaction of light with various tissues of the teeth combined with new improved layering concepts, and newer composite restorative materials help in achieving natural-looking restorations. The successful use and application of these materials depends on the operator’s understanding and knowledge of their intrinsic properties, and the ability to master

related clinical protocols. Due to the material and optical differences of natural teeth and composite restorative materials, production of a natural-looking restoration requires stratification of different restorative materials in different ways.

**Techniques:** Many techniques with differing levels of complexity have been described for layering composite restorations to achieve esthetic restorations - Simplified technique, Bilaminar technique, Vanini’s stratification technique, Trilaminar technique, Polychromatic/ Newton Fahl’s technique. A thorough understanding of this helps the clinician provide highly esthetic natural-appearing restorations for anterior teeth, by stratifying different restorative materials in different ways.

**Conclusion:** The ability to recreate tooth structure using composite materials to achieve the same structural outline, morphology and texture is very challenging.

New improved layering concepts rely on a better understanding and knowledge of tooth histology, and light interaction with natural tissues. Excellent esthetic results are obtained by the improved qualities of the new composite materials and the choice of stratification technique.

**Clinical Significance:** Depending upon the patient's demands, time at hand, materials available, and the outcome desired, the clinician can plan the stratification technique to be followed to best address the patient's requirements.

**Keywords:** Anterior composite restoration, Composite layering, Layering technique, Direct composite.

### **Introduction**

The perceived colour of a tooth is due to the harmonious interaction of light with dentin and enamel. The synergy between the enamel and dentin makes the tooth an object that uniquely interacts with light; enamel allows light to pass through it, while dentin stops it<sup>1</sup>. Both enamel and dentin have unique properties when analyzed separately or together. The physical and optical properties of enamel and dentin are subject to change with age<sup>2</sup>. This proves an interesting challenge in restoring teeth in the esthetic zone as the restorative materials used must be capable of simulating natural tooth form and appearance. It is impossible to have a universal solution or technique to restore tooth structure loss in the esthetic zone as every tooth is unique in its appearance. This necessitates the integration of natural appearance, function, esthetics, along with different restorative materials and techniques for the success of an anterior restoration.

The natural appearance of anterior teeth can be simulated by stratifying different restorative materials in different ways. The understanding and knowledge of tooth anatomy, the interaction of light with various tissues of the teeth, combined with new improved

shading/layering concepts, and newer composite restorative materials help in achieving natural-looking restorations.

### **Understanding Dentin**

Dentin is the innermost hard tissue layer of the tooth. The base, hue and chroma of the tooth are determined by the dentin. Dentin has a high chromaticity with a remarkable opacity with a reddish yellow hue<sup>3</sup>.

### **Hue and Chroma**

The chroma of the tooth is highest towards the Centre of the tooth while the saturation decreases towards the surface. The gradual change of chroma and opacity is also evident from the cervical third to the incisal third. The closer to the incisal edge, the lesser the chroma and higher opacity<sup>4</sup>.

The effect of enamel on the appearance of dentin is discussed later.

### **Effect of Ageing on the Appearance of Dentin**

The physiologic ageing process causes changes in dentinal colour throughout life<sup>5</sup>. There is a slow increase in the orange-red component of the tooth caused by ageing. In a young tooth, the dentin has low chromaticity and the high value of enamel hides the dentinal colour, increasing the overall value of the tooth. In an adult, the dentin has moderate chromaticity and the enamel slightly increases the value of the entire tooth. In an older tooth, the dentin has high chromaticity and the enamel increases the value of the tooth very little<sup>6</sup>.

### **Opacity, Translucency, and Fluorescence of Dentin**

Dentin is unique in its optical properties; it is more opaque than enamel and has a certain degree of translucency. The dentin hides dark colour but also allows light to pass efficiently, i.e., it is an efficient opaquer<sup>7</sup>.

Fabrication of a small restoration to be placed in healthy surrounding tissue necessitates the use of a more

translucent material to display and reflect the underlying tooth structure would, whereas, for a large restoration, selection of an opaque material to mask the dark background of the oral cavity would be appropriate.

The dentin composites available from various composite manufacturers have significant differences in their opacities. To select the correct composite resin the professionals, need to have a good knowledge of the opacity and translucency of the different brands. Presence of proteins, such as photochromes and fluorophores, make dentin a highly fluorescent tissue<sup>8</sup>. Fluorescence provides an "inner glow" that contributes to the vital appearance of the natural tooth. Diminished fluorescence is seen due to ageing of dentin (because of protein loss, tissue mineralization, and pigmentation), in endodontically devitalized teeth (due to dehydration, loss of dentinal volume, and breakdown and loss of proteins due to chemical substances such as hypochlorite)<sup>9</sup>. Such teeth should be restored with a highly fluorescent inner layer of dentin to regain lost value and fluorescence.

### **Understanding Enamel**

Enamel is responsible for regulating the value of the tooth and is characterized by a high degree of translucency. Enamel is a complex system that absorbs, reflects, and transmits light. The crystalline components of enamel allow free passage of light; the organic matter, in contrast, blocks light, creates an internal diffusion of light, resulting in a white appearance<sup>10</sup>. The highly translucent prismatic structure along with the more opaque interprismatic matter makes enamel both translucent and a high-value substance at the same time<sup>11</sup>.

### **Effect of Enamel Thickness on Appearance**

The thickness of enamel changes across the tooth. Increased translucency is seen in the incisal third;

however, in the middle and cervical thirds, there is an increase in opacity due to proximity to the dentin. Increased thickness of enamel raises the value and reduces the prominence of the underlying strata.

The value of composites is increased by increasing the whiteness, but unlike enamel change in their value also changes their translucency<sup>12</sup>. As a rule, an increase in value increases opacity<sup>12,13</sup>. With high translucency composites, restorations gain the colour depth and illusion of a natural tooth.

If the outer layer has poor translucency, it will mask the underlying dentin, its characterizations and effects. An excessively translucent enamel composite will result in excessive absorption and minor reflection of light resulting in a loss of value and a greyish restoration. Many of the composite resins do not have the same refractive index as natural enamel<sup>14</sup>, so placing composite in the same thickness as the enamel leads to the restoration having an unnatural appearance. This challenge is overcome through layering, placing enamel composite layers that are thinner than those of the natural teeth.

### **Enamel Ageing**

The enamel becomes increasingly mineralized over time. Mineralization of enamel affects the value: less translucent and bright enamel, seen in young and white teeth, is due to its hypo mineralized and porous nature<sup>15,16</sup>. On the other hand, fully mineralized enamels have higher translucency, and therefore are very transparent<sup>17</sup>.

Because of physiologic wear, enamel becomes smoother and thinner. Enamel wears out on its surface, causing light to penetrate more efficiently, looking less white, and revealing the underlying dark and chromatic dentin.

Being a permeable structure, enamel absorbs colour

pigments producing subtle changes in its colour over time<sup>18</sup>.

### **Ideal Requirements of Enamel and Dentin Composites:**

The ideal properties of enamel and dentin composites are listed in table 1. However, the current choice of composites is limited to high fluorescence, adequate opacity, correct hue and chroma and favorable physical properties<sup>19</sup>.

### **Techniques of Anterior Composite Stratification**

The average Hue of incisors and canines is 580 nm (red-orange), corresponding to A2, A3, and A3.5 in the Vita shade guide<sup>20</sup>.

Superimposition of different dentinal colour helps achieve a more natural, deeper, and esthetic dentinal body, avoiding monochromatic effects and the risk of having the restoration look like a patch.

To simulate proper shades, it is important to add chromatic layers in the depths of the cavity to develop a chromatic core. The larger the cavity preparation, the more colour should be included in the stratification. In a very small cavity preparation, one dentin shade can be used optimally.

### **Simplified Technique**

It is possible to develop less chromatically complex teeth in a simple way using fewer colours<sup>21</sup>. This can be achieved by using two dentin shades and one enamel shade, depending on the size of the cavity.

The use of two dentin shades allows us to obtain halftone colours (Figure 1). The following formulae may help to produce halftone and other colours:

$$\bullet AX = AX+1 + AX$$

$$\bullet AX.5 = AX+2 +$$

AX Although the colours do not end up as deep as can be attained with the advanced techniques, their accuracy is quite close to the desired chromaticity<sup>22</sup>. Such techniques allow clinicians to simplify their stratification

methods and save time, particularly in the lateral-posterior area.

### **Bilaminar Technique**

As the name suggests, this technique involves layering composites in two layers. There are two approaches to this technique of stratification:

#### **(a) Non-histo-anatomical**

One set of body composites, usually following the Vita Classic shading system, offering different hues in varying chroma levels are used generally. Body shades exhibiting an intermediate opacity (between natural dentin and enamel values), a few 'opaque' and 'incisal' composites (depends on manufacturer designation) usually complete the system.

In this technique, first, a mono laminar chromatic build-up of the restoration is done and then the second layer of an incisal/translucent shade is added on the surface to emulate translucency.

While this technique provides a simple approach, the aesthetic quality of the resultant restoration is restrained by its oversimplified, non-histo-anatomical shading approach.

#### **(b) Natural Layering Concept**

Mimicking the layers in the natural tooth is the next logical step in the development of restorative materials and restorations – leading to a layering concept aptly named the 'natural layering concept'. This technique has been developed by thoroughly studying the optical properties, age and functional variations of natural dentin and enamel<sup>23</sup>.

Spectrophotometric measurements of natural teeth belonging to various VITA shade groups has shown that distinct dentine colours in composite restorative systems could be avoided, and that enamel composites should have different value/opacity levels and different tints<sup>24</sup>. Similarly, the use of different dentin opacities is not

supported due to the limited opacity of natural dentin within a given range of chromatic variation. These composite systems (e.g., Miris2, Colten/whale dent; Ceram-X duo, Dentsply) make use of universal dentin shades of a single opacity level with a wide chroma range and multitint/multi-translucency enamels. The enamel composites are generally classified as ‘young’ (white tint, reduced translucency), ‘adult’ (neutral tint, intermediary translucency) and ‘elderly’ (yellow tint, higher translucency). Optional ‘effect’ shades or tints may be included for individualization.

The base hue of the tooth is first determined, and the dentin composite is selected accordingly. This is followed by determination of the type of enamel composite required. These are then layered sequentially (Figure 2). The ‘effect’ shades/tints are layered in between the dentin and enamel composites.

#### **Vanini’s Stratification Technique**

Stratification of three dentin shades according to the technique advocated by Dr. Lorenzo Vanini allows the development of more colours than are commercially available (Figure 1)<sup>25</sup>. This technique involves the construction of a multilayered dentinal core followed by a thin (0.5 mm) layer of medium-value enamel. The multiple layers of composite provide an illusion of depth.

The following should be kept in mind while creating the dentinal core:

- High chromaticity of the dentinal core
- Chromatic desaturation from cervical to incisal and from palatal to facial
- Build up in multiple layers to gain depth (prevents monochromatic structures)
- Control of contraction and polymerization shrinkage through multilayer application.

The following formulae may be used as a template for producing a more chromatic and “deeper” dentinal core:

- $A_X = A_{X+2} + A_{X+1} + A_X$
- $A_{X.5} = A_{X+3} + A_{X+2} + A_X$

#### **Trilaminar Technique**

The trilaminar technique makes use of dentin and chromatic enamel shades, with different hues with varying chroma, and one or several incisal/translucent shades. The dentin composites exhibit opacity close to or higher than natural dentin, while enamels show an intermediate opacity, between natural dentin and enamel. The restoration is built up in a polychromatic manner, with different opacities and chroma levels from the cavity depth to the restoration surface.

Effective application of this technique requires a long learning curve, hence is being progressively replaced by new simpler and more reliable ones<sup>26</sup>.

#### **Polychromatic/ Newton Fahl’s Technique**

This polychromatic technique consists of using a chromatic enamel (Vita) or body composite on the margin zone, and an achromatic enamel (non-Vita) composite on the incisal portion of the restoration. Few dentin composites are required<sup>26</sup>. The actual number of layers in each restoration will then be determined by the polychromaticity intended. For example, two or three shades may be sufficient in cases where the teeth have minimal chromatic variation and little or no incisal translucency or mamelon expression. The multiple shades may be required in teeth displaying greater chromatic variation with accentuated incisal characterizations.

This technique utilizes a wider range of composites from many different composite systems (VITA based and non-VITA based) and blends them to create extremely esthetic restorations. Dentin shades with an average hue-chroma level (usually A shades of varying chroma) and a degree of opacity closest to natural dentin can be selected from any restorative system. The enamel shades

with the ideal physical and optical properties can be selected from any commercially available system. Non-VITA based milky-white semi-translucent enamels are used to create a lingual shell to simulate whitish-amber incisal halos. Non-VITA based translucent effect enamels are used internally, around mamelons to impart a bluish opalescence. Finally, a selection of different body and value enamels complete the collection. This technique involves first creating a palatal shelf with translucent composites to establish the incisal halo if required. This is followed by layering dentin composite of the appropriate hue and chroma. This contributes to the base hue, chroma and opacity of the restoration.

Next, the translucent effect enamels are placed between the mamelons created by the dentin layer to provide opalescence. Body enamels are applied as a final chromatic layer at the transition between tooth structure and restoration, most frequently at the cervical and middle thirds due to the amplified perception of surface hue and chroma in those areas. The degree of opacity of the area being restored will determine the selection of body enamels of lower or higher opacity. The thickness of body enamels varies on a case-to-case basis. This is crucial in determining the final hue, chroma and value of the areas where they are used. Value-based enamels make up the final layer and cover the entire facial aspect in case of a direct veneer. They may be applied over the incisal surface, and feathered over the middle third of the facial surface to allow the perception of underlying characterizations, such as mamelons, opalescence, craze lines and white spots<sup>27</sup>.

Figure 3 explains the application of the various layers. One of the challenges posed by this technique is that it requires the clinicians being sufficiently knowledgeable to gather the most suitable shades from within the broad

spectrum of commercially available brands or utilizing one single system with efficacy.

### **Reverse Technique**

The use of this technique is indicated in discoloured teeth or to opacify undesirable dark features of teeth. Whiter opaque dentin composites are used for this purpose.

Whiter opaque dentin composites are placed in the innermost portion for masking, followed by layering of chromatic dentin or body composites, near the surface in order to increase the chromaticity. The mamelons can be personalized as well.

It must be remembered that, for all multilayering techniques, the final appearance of the restoration is influenced by several factors - the opacity of the deeper layers, the translucency of superficial layers, hue and chromaticity of the deeper and superficial layers, the value of the superficial layers and thickness of the more superficial layers.

Table 2 provides a summary of the different layering techniques discussed.

### **Reproduction of the Incisal Edge**

Most of the optical phenomena observed in a tooth are concentrated at the incisal edge. The incisal edge is formed exclusively of enamel, but the incisal third close to the middle third also possesses dentin. This area shows a varying degree of translucency strongly dependent on the ratio of enamel-dentin thickness<sup>28</sup>. Reproduction of the incisal area greatly depends on the thickness of the dentinal body.

The shape of dentin must be adapted according to the translucency of the incisal third. A thin dentinal core is required for a highly translucent effect, a medium thickness is needed for normal translucency, and a thick layer is needed when this area is opaque. These

thicknesses help in determining the space available for opalescent masses and the enamel.

### **Conclusion**

The ability to recreate tooth structure, using composite materials to achieve the same structural outline, morphology and texture is very challenging. New improved layering concepts rely on a better understanding and knowledge of tooth histoanatomy, and light interaction with natural tissues. Excellent esthetic results are not obtained only because of the improved qualities of new composite materials, but by combining these with appropriate stratification techniques. Layering concepts have progressively evolved from a simplistic, bilaminar technique to multi-layering approaches. One of the most achieved concepts involves polychromatic layering making use of a variable number of layers, driven by the natural tooth optical composition.

Parallely, a simplified system was developed with a reduced number of layers (dentin & enamel layers, with effect shades if required) known as the natural layering concept, with the aim to achieve the same optimal esthetic integration and natural colour reproduction. In view of the above, for obtaining the best esthetic result, one must first analyze the optical composition of the tooth followed by application of an adequate number of layers required for optimal integration of the restoration with surrounding natural tissues.

### **Clinical Significance**

Along with knowledge of the dental tissues, a clinician needs to know methods to best reproduce the lost tooth structure. Each patient is unique and has unique requirements. While some patients may be extremely concerned about the esthetic appearance of their teeth, others may only be concerned about the tooth structure that has been lost. In such varied situations, a clinician

must be able to best utilize his time and efforts to meet the patient's needs and expectations. Depending upon the patient's demands, the time at hand, and the materials available at hand, the clinician can plan the type of stratification techniques to be followed to best address the patient's requirements.

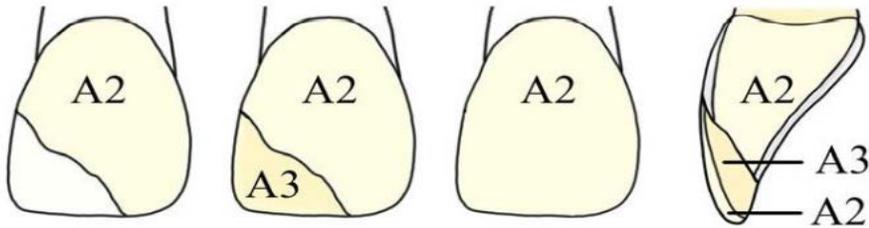
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Figure 1: Simplified Technique of Layering and Vanini's Stratification Technique.

### SIMPLIFIED TECHNIQUE OF LAYERING



### VANINI'S STRATIFICATION TECHNIQUE

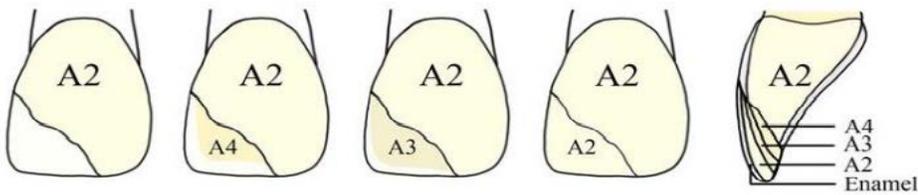


Figure 2: Natural Layering Concept.

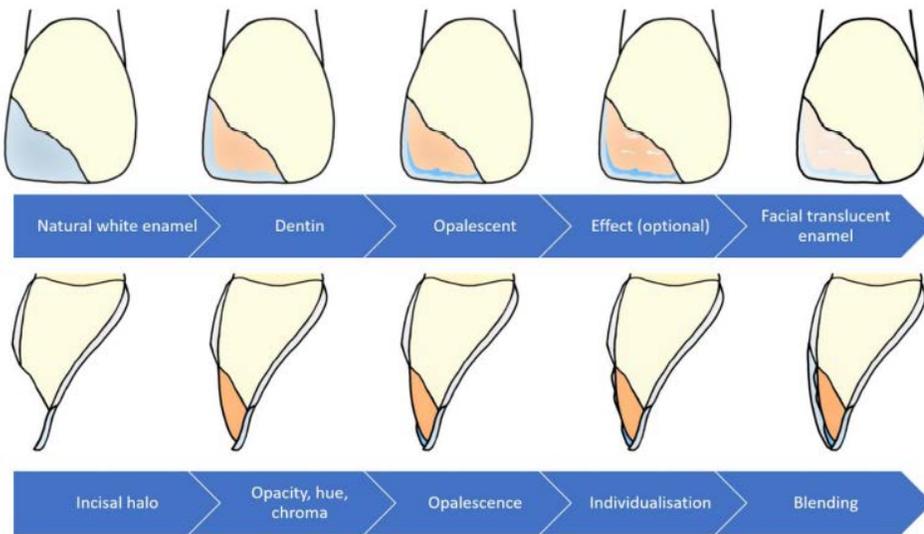


Figure 3: Polychromatic Technique of Layering.

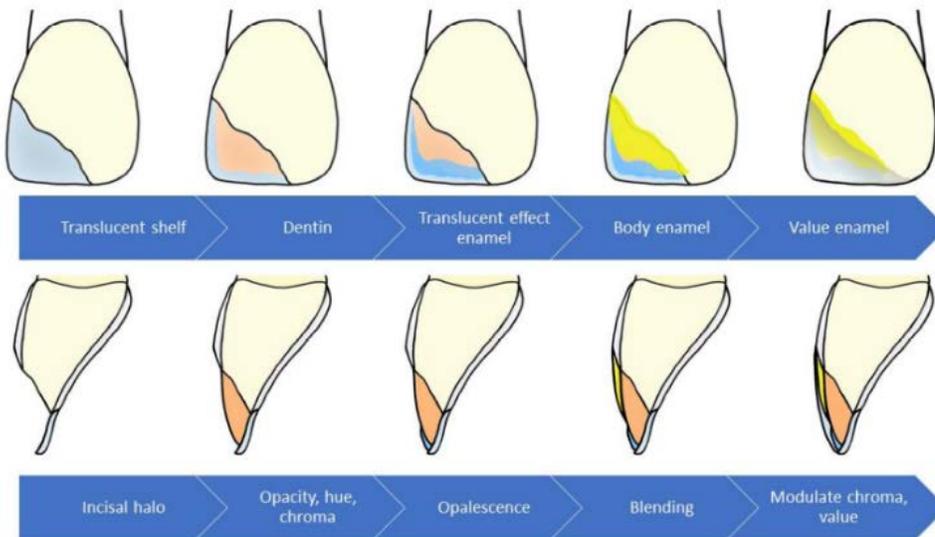


Table 1: Ideal Properties of Enamel and Dentin Composites.

Ideal properties of enamel composites	Ideal properties of dentin composites
<ul style="list-style-type: none"> <li>• High opalescence</li> <li>• Refractive index equal to that of natural enamel</li> <li>• High translucency</li> <li>• Calibrated luminosity for each situation</li> <li>• Hardness after polymerization</li> <li>• High polishing</li> <li>• Smooth and stable handling</li> <li>• Reflectivity</li> <li>• Stability in the oral environment</li> <li>• Ability to add Value by increasing thickness</li> </ul>	<ul style="list-style-type: none"> <li>• High Young modulus</li> <li>• High elasticity</li> <li>• Fluorescence</li> <li>• Low refraction index</li> <li>• Optimal opacity-translucency</li> <li>• Orange-red Hue</li> <li>• Ability to opacify</li> <li>• High iridescence</li> <li>• Efficient light transmission</li> <li>• Compression resistance</li> </ul>

Table 2: Summary of the Different Layering Techniques.

Technique	Technique (from depth of restoration to surface)	Application, difficulty
Simplified technique	Dentin shade 1 → Dentin shade 2 → Enamel shade	Small restorations Beginner friendly
Bilaminar technique	<b>4.1. Non-histo-anatomical</b> Chromatic body shades → incisal/translucent shade on the surface <b>4.2. Natural layering concept</b> Dentin composite → 'Effect' shades/tints → Enamel composite of appropriate tint/translucency	Small restorations Beginner friendly Adequate aesthetics with Natural Layering Concept
Vanini's stratification technique	Multilayered high chromaticity dentinal core → Final layer of medium-value enamel (0.5 mm thick)	Small to moderate restorations Acceptable aesthetics Moderate difficulty
Trilaminar technique	Polychromatic build-up with different opacities and chroma levels from the cavity depth to the restoration surface	Moderate to large restorations Acceptable/good aesthetics Learning curve, experience
Newton Fahl's/polychromatic technique	Palatal shelf (translucent composites) → Dentin composite → Translucent effect enamels placed between the mamelons → Body enamels at the transition between tooth structure and restoration → Final layer of value-based enamels	Highly suitable for cases requiring veneers Excellent aesthetics Learning curve, experience
Reverse technique	Whiter opaque dentin composites (masking effect) → Superficial layers of chromatic dentin or body composites (increase chromaticity)	Cases requiring veneers or otherwise that require masking Moderate difficulty