Fig. 21: Another example of the combined polychromatic effects of dentine and the opalescent effects of enamel.

Fig. 22: Vanini's classification of enamel-opalescent effects in graphic and textual form. Vanini divided the effects into three broad categories: intensive effects, opalescent effects and characterisation. Each group was further divided into more divisions as outlined in Table 1. Careful consideration of this classification will surely convince the reader that the vast majority of dentine and enamel effects fall within this grouping. Understanding and application of this categorisation will present the clinician with a very simple roadmap to color matching. Vanini has further simplified the procedure by studying the distribution of the actual color involvement of the various effects. Thus by memorising three categories with a total of fourteen subdivisions, the clinician has a definitive route to chart the color matching process without the need for a “shade guide and, more importantly, without the need to possess exceptional artistic ability. The procedure is simple and, even further by the availability of a purchasable “chromatic chart” and the whole process of color matching can be recorded.

A polychromatic effect. Vanini (1996) studied this effect and defined and applied the term "chromatic banding" to the polychromatic effects (Figure 19). Traditionally, chromatic banding has been described at the gross level as consisting of three broad areas:

- The cervical third
- Middle third
- Incisal third

The chroma is most saturated in the cervical area, gradually decreasing through the middle third into the incisal third which exhibits the lowest chroma. Vanini demonstrated that even within the three broad bands there are areas of dense opacity and saturated chroma mixed with areas of less saturation, giving rise to a true polychromatic appearance. These areas can be organised in a definite pattern resembling bands of differing chroma, or there might be a random scattering of differing chromas. Organic pigments present within the microstructure of dentine are responsible for fluorescent effects giving undulating areas of white or blue.

**Enamel Effect**

The inorganic organized arrangement of the enamel prisms, the varying thickness of enamel over the dentine contours and the presence of organic protein pigments allows light to be reflected, refracted and transmitted. The translucent and opalescent characteristics of enamel impart value as well as areas of intense color and/or opalescent effects to the underlying dentin giving sparkle and vitality to the tooth. The thicker the enamel, the more light is reflected and refracted, thus increasing the luminosity and hence the value giving a whiter appearance.

**Combined Effects of Enamel & Dentine**

The observed color of a tooth is achieved through the combined optical effects of enamel and dentine. Therefore, it is imperative to understand the influence that each component makes on the tooth's basic properties.

The opaque dentine, exhibiting the attributes of hue and chroma, has the tendency to decrease the value of enamel, thus moving the overall color towards the grey. If the enamel is very thin and the dentine very saturated (such as the cervical area) then the hue of the dentine dominates the overall perception. Finally, as the enamel thickens and the dentine decreases in density (middle third) does the value of the enamel increase, leading to a whiter effect. Careful observation of the tooth will show that the polychromatic nature of dentine will exert similar effects on the value, giving rise to a pattern of variance in the value of enamel that matches the polychromatic pattern of dentine (Figure 20).

**Opalescent, Translucent & Intensive Effects**

Opalescence in a tooth is caused by minute particles in the translucent enamel reflecting and refracting light. This particular matter is so minute that only the shortest wavelengths are reflected, thus creating a blue gleam. In the natural tooth this occurs usually at the edges of the incisal third where the tooth is devoid of dentine, causing the familiar blue halo. As the dentine thickness increases, more wavelengths are reflected leading from grey to white opalescent effects (Figure 21).

Vanini (ca. 2002) in an as-yet unpublished study demonstrates that there appears to be a definitive pattern to the transmittance properties of enamel. This pattern can be classified into categories and further divided into effect elements. Vanini's work and study still requires universal acceptance and scientific verification. Nevertheless, it's sheer pragmatism and practicality make it an exquisite diagnostic tool in tooth color matching and provides a wonderful communication tool between clinicians, manufacturers and laboratory technologists. Vanini postulates that the sum total of all opalescent, translucent or enamel effects fall into one of three categories:

- **Intensive effects**
- **Opalescent effects**
- **Characterisation**

**Intensive Effects** present discrete but intensive areas in the enamel surface, usually of a milky-white nature. A typical example of an intensive effect is the stain associated with hypermineralization (fluorosis) of the enamel structure. The opalescent category attempts to classify the distribution and appearance of typical enamel opalescent effects. The presence of the blue halo in many teeth, both anterior and posterior, is typical of opalescent effects. This halo can actually be classified by describing its physical appearance as well as shape, melanin, split mellow, window or comb. A fifth division will occur in the elderly patient where the thinning of the incisal edge has occurred, enamel has thinned and extrinsic stain mixes with the opalescent area producing an opalescent stain usually of a white/amber color. The final category, characterisation, describes the two most common examples of character effects, the stain and crack as well as the areas of definitive effects that can surround the areas of opalescent or intensive effects.

As an example, immediately below and above the opalescent halo there is usually an area of solid enamel effect accentuating the halo and thus would be defined in the characterisation category as amam-melon or marginal effect. Therefore, by subdividing the opalescent, translucent or enamel effects into three broad categories, and further dividing each category into subcategories, a predictable, repeatable and easily describable roadmap for color matching can be recorded and charted (Figure 22).

**Aging Effects in the Adult Tooth**

Young teeth are generally characterized by white, bright opalescence (Figure 23) whereas aged teeth are usually dark opaque and worn (Figure 24).

What happens? Young teeth have a thick, dense vascular, and opaque dentine surrounded by thick enamel. The thick intact enamel masks and reduces the opaque effects of the dentine. The young enamel shows marked opalescent effects and in the incisal area the halo effects are obvious. With aged teeth, the dentine blood supply diminishes and the tubules become sclerotic. Although sclerotic dentine is slightly more translucent, the overall chroma increases and the dentine becomes darker.

The enamel wears and thins with resulting reduced value as well as allowing more of the opaque dentine to show through. The thinned enamel shows reduced opalescent effects, particularly at the incisal edge where loss of enamel due to functional wear, Accumulated stains also darken the tooth.

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What happens is available from the Publisher.

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**Fig. 21: Young, bright smile.**

**Fig. 22: Vanini's classification of enamel-opalescent effects in graphic and textual form.**

**Fig. 23: Young, bright smile.**

**Fig. 24: The smile of an older person.**

**Fig. 25: The Chromatic Chart. Diagnostic map for color matching (Micreriun, Genna, Italy; Optident, Ilkley, Yorkshire).**

**Table 1: Intensities, Opacities, Characterisations.**

<table>
<thead>
<tr>
<th>Intensities</th>
<th>Opacities</th>
<th>Characterisations</th>
</tr>
</thead>
<tbody>
<tr>
<td>High</td>
<td>Middel</td>
<td>Low</td>
</tr>
<tr>
<td>Dense</td>
<td>Transparent</td>
<td>Opalescent</td>
</tr>
<tr>
<td>Opaque</td>
<td>Transparent</td>
<td>Translucent</td>
</tr>
<tr>
<td>Characterisation</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Stained</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cracked</td>
<td></td>
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</tbody>
</table>

**Fig. 26: Another example of the combined polychromatic effects of dentine and the opalescent effects of enamel.**

**Fig. 27: What happens in the elderly patient?**

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**Author Info**

David Klaff is past president and founding member in the British Academy of Aesthetic Dentistry (BAAD). He currently runs a private practice on the London/western Middle East and has lectured extensively on aesthetic dentistry in Europe, the Middle East and the United Kingdom. He wishes to thank Micreriun (Genna, Italy), Dr Vanini (Como, Italy) and Optident Ltd, Ilkley, Yorkshire) for permission to use original slides and material.