

Modern Approaches to Coloristics in Permanent Lip Makeup to Achieve Natural Shades

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Abstract: *The article examines modern approaches to coloristics in permanent lip makeup aimed at achieving natural and stable aesthetic results. The relevance of the topic is determined by the increasing demand for subtle, non-artificial pigmentation techniques that account for individual lip chromatic profiles. The novelty of the work lies in synthesizing instrumental color measurement data, pigment chemical behavior, and procedural depth-control principles into a unified methodological framework. The study reviews the composition of pigments, patterns of chromatic transformation during healing, and factors affecting long-term tone stability. Particular attention is given to hyperspectral and reflectance-based assessment techniques, as well as criteria for pigment safety and regulatory compliance. The aim of the study is to identify key determinants of natural shade formation and propose practical guidelines for selecting pigments and application parameters. The article will be useful for permanent makeup practitioners, cosmetologists, and researchers in dermatological pigmentation science.*

Keywords: permanent lip makeup, coloristics, pigment selection, hyperspectral measurement, chromatic stability

1. Introduction

The development of permanent lip makeup techniques has increasingly shifted toward outcomes that replicate natural lip coloration rather than produce decorative or saturated effects. Demand for subtle enhancement is influenced by client preferences for soft contouring, translucency, and individualized shade matching. Achieving such results requires understanding how lip tissue structure, pigment chemistry, and optical properties interact within the dermal environment.

The aim is to identify determinants of natural shade formation in permanent lip makeup and to develop evidence-based guidelines for pigment selection and dermal application parameters. Research tasks include:

- 1) To describe the chromatic characteristics of natural lips and identify shade typologies relevant to individualized pigment selection.
- 2) To examine the chemical composition and behavioral properties of pigments used in permanent lip procedures.
- 3) To systematize criteria for ensuring color stability, biocompatibility, and long-term aesthetic consistency.

The novelty of the work lies in integrating instrumental lip color measurement methods with procedural guidelines for personalized pigment planning and controlled dermal implantation depth.

2. Methods and Materials

The study is based on analysis and synthesis of published research on chromatic assessment, pigment chemistry, safety regulation, and dermal color stability. The study of natural lip chromatic parameters and hyperspectral measurements was conducted in the work of H. Vergnaud and others [1]. The composition and classification of pigments used in tattooing and permanent makeup techniques were examined in the study of A. Charuta and colleagues [2]. The long-term color transformation of inorganic pigments and principles of controlled application depth were analyzed in the research of E. Andreou et al. [3]. Reflectance spectroscopy as a method

for evaluating cutaneous optical response was discussed in the work of A. Mancuso and co-authors [4]. Chemical variability and safety risks in pigments were assessed in the studies of H. Colboc et al. [5] and D. Bakova et al. [6]. Regulatory evaluation of heavy metal concentrations in pigments was provided by M. Ćwieląg-Drabek et al. [7]. Laser-based pigment behavior and light exposure effects were researched by D. Cecchetti and others [8]. To conduct the study, comparative analysis, structural systematization, and critical interpretation of scientific sources were applied.

3. Results

Current approaches to color formation in permanent lip makeup rely on accurate measurement of natural lip tone, controlled pigment selection, and prediction of color behavior during healing and long-term wear (Figure 1).

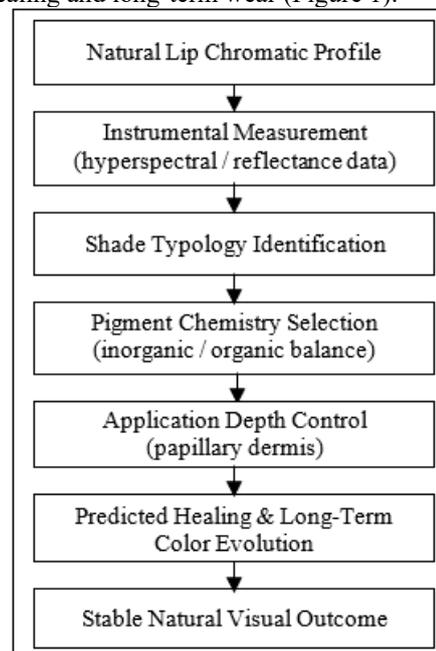


Figure 1: Conceptual scheme of natural shade formation in permanent lip makeup (compiled by the author based on [1–4])

Instrumental measurement of natural lip color provides a foundation for color matching. A hyperspectral system applied to lip analysis demonstrated stable repeatability across multiple sessions and devices, with consistent extraction of L*, a*, b*, C*, and h parameters for both upper and lower lips [1]. In that experiment, data from 19 participants produced 228 measurement points and revealed that the lower lip typically displays higher chroma and redness and marginally higher lightness, forming a reproducible distribution pattern [1]. The separation of three lip color typologies based on spectral characteristics proposed a structured basis for selecting target shade families rather than relying solely on visual assessment. Below is the systematization of shade typologies (Table 1).

Table 1: Typological categories of natural lip shades and their application relevance (compiled by the author based on [1])

Lip Shade Typology	Dominant Visual Characteristics	Recommended Pigment Undertones	Application Strategy Focus
Light–Yellowish Tone	Lower chroma, soft warmth, subtle contrast to surrounding skin	Neutral or slightly cool-toned pigments	Maintain controlled density to avoid oversaturation
Dark–Redder Tone	Higher chroma and saturation, pronounced natural contrast	Warm pigments diluted to soften intensity	Apply soft gradient blending to retain natural relief
Light–Red Tone	Balanced chroma with gentle warmth and even color distribution	Soft warm shades balanced with neutral modifiers	Maintain smooth shading to preserve translucency

This information serves as a reference for technicians when calibrating pigment undertones and target density. Color reproduction in permanent lip makeup depends strongly on the chemical nature of pigments. A review of pigments used in tattooing and permanent cosmetic procedures documented that pigment mixtures often contain inorganic oxides, organic chromophores, and carrier components suspended in solvents [2]. During application, between 0.4 mg and 14.36 mg of pigments may be introduced per 1 cm² of skin, which establishes long-term chromatic presence [2]. The choice between inorganic and organic pigments influences opacity, translucency, saturation, and long-term stability. Below is the comparative characterization (Table 2).

Table 2: Comparative characteristics of inorganic and organic pigments in permanent lip makeup (compiled by the author based on [2, 3])

Parameter	Inorganic Pigments (e.g., Iron Oxides)	Organic Pigments (e.g., Carbon-based or Synthetic Dyes)
Visual Appearance	Muted, natural, soft diffusion	Bright, vivid, high chromatic intensity
Particle Size & Behavior	Larger particles, slower migration, and predictable fade	Smaller particles, more mobile within the dermal tissue
Long-Term Color Stability	Gradual warm/red shift due to oxidation	Potential uneven fading depending on UV exposure

Interaction with Tissue	Integrates predictably into lip microrelief	More dependent on vascularity and metabolism
Optimal Use Case	Natural enhancement and subtle correction	High-saturation artistic or accent lip effects

Inorganic iron oxide pigments are commonly used in lip tattooing to achieve natural, muted tones with reliable coverage, yet their oxidation in vivo can shift color toward warmer reddish shades after several months [3]. This behavior requires pre-procedure adjustment of pigment undertones to avoid the appearance of unintended warmth during healing.

Color shifts over time are explained not only by oxidation but also by the interaction between pigment particle size, depth placement, and light scattering. In an experimental comparison between traditional tattoo ink and permanent makeup pigments placed at equal dermal depth, inorganic particles demonstrated gradual diffusion reduction and visible fading, while organic particles with a smaller size maintained visual intensity for longer periods [3]. The fading behavior of inorganic pigments can be considered advantageous for lip procedures intended to restore subtle natural coloration rather than bold saturation, allowing incremental corrections.

Skin structure affects final optical perception. The vermilion region reflects proportionally more red wavelengths between 600 nm and 700 nm, which explains the naturally reddish appearance independent of added colorants [1]. Reflectance spectroscopy applied to the lip surface can indicate hydration status, vascular contribution to tone, and uniformity of pigment interaction across microrelief [4]. Non-invasive spectral imaging, therefore, supports pre-procedure assessment and post-procedure monitoring to confirm that color integration aligns with intended outcomes.

Chemical stability of pigments influences color durability and safety. Chemical analysis of tattoo and permanent makeup inks revealed the presence of metal oxides, phthalates, and aromatic compounds, with variability in purity across manufacturers [5]. Trace contamination with chromium, cobalt, nickel, or mercury has been detected in some pigment batches, which introduces potential for delayed inflammatory or hypersensitivity reactions [2]. A systematic review highlighted persistent reports of skin irritation and granulomatous responses in association with pigments used in both artistic and cosmetic tattooing, indicating the need for standardized purity criteria [6]. Measurements of pigment samples available in the European market documented heavy metal concentrations that require ongoing regulatory evaluation, particularly after the introduction of REACH restrictions [7]. These findings influence colorists' pigment selection strategies, favoring certified pigment lines with documented composition stability. Below is the structured overview of selection criteria (Table 3).

Table 3: Criteria for safe pigment selection in permanent lip makeup practice (compiled by the author based on [2, 5–7])

Selection Criterion	Description	Practical Implementation
Ingredient Transparency	Disclosure of pigment base components and carriers	Use pigments with batch certificates and traceable labeling
Regulatory Compliance	Alignment with REACH and dermatological safety standards	Verify manufacturer documentation and compliance codes
Heavy Metal Control	Absence of critical contaminants such as Cr, Co, Ni, Hg, Pb	Request laboratory analysis reports or independent testing
Photostability & UV Behavior	Predictable chromatic evolution under natural and artificial light	Plan maintenance based on anticipated fading pathways
Physiology-Aligned Shade Planning	Undertone matched to lip vascularity, hydration, and tissue density	Select pigments considering baseline lip hue and microrelief

Color correction and maintenance form an integral part of modern lip coloristics. Due to predictable fading patterns of iron oxides, neutralization techniques are applied to avoid undesired tonal shifts. For example, selecting pigments with slightly cooler undertones mitigates the gradual warm shift observed after six to eight months of wear. The long-term aesthetic outcome depends not only on pigment chemistry but on depth control during application. If pigments are placed deeper, scattering of shorter wavelengths increases, causing cooler color perception; this effect underscores the need for shallow, uniform implantation in the papillary dermis for natural lips.

Laser treatment research contributes to understanding pigment stability. Comparative laser exposure of green pigment mixtures demonstrated that different wavelengths induce distinct photothermal and photochemical transformations, altering reflectance properties without fully removing embedded particles [8]. This knowledge clarifies why lip color may evolve non-uniformly under sunlight exposure or cosmetic light-based treatments. The practitioner must account for environmental photon exposure when predicting pigment longevity.

Color naturalness depends on controlled contrast between the vermilion and the surrounding skin. Subtle enhancement strategies avoid sharply defined borders or saturated fills and instead replicate natural gradient transitions. The use of spectral lip color categorization supports shade selection tailored to individual lip typologies rather than generalized palettes. For instance, individuals belonging to the typology characterized by lighter and yellower inferior lip tone require pigments with moderated chroma to avoid excessive saturation, while those with darker and redder inferior lip tone benefit from reduced density placement and diluted warm pigments to maintain natural depth [1].

The combination of precise measurement, informed pigment chemistry selection, controlled application depth, and predictive color evolution provides a structured approach to achieving natural lip color outcomes (Figure 2)

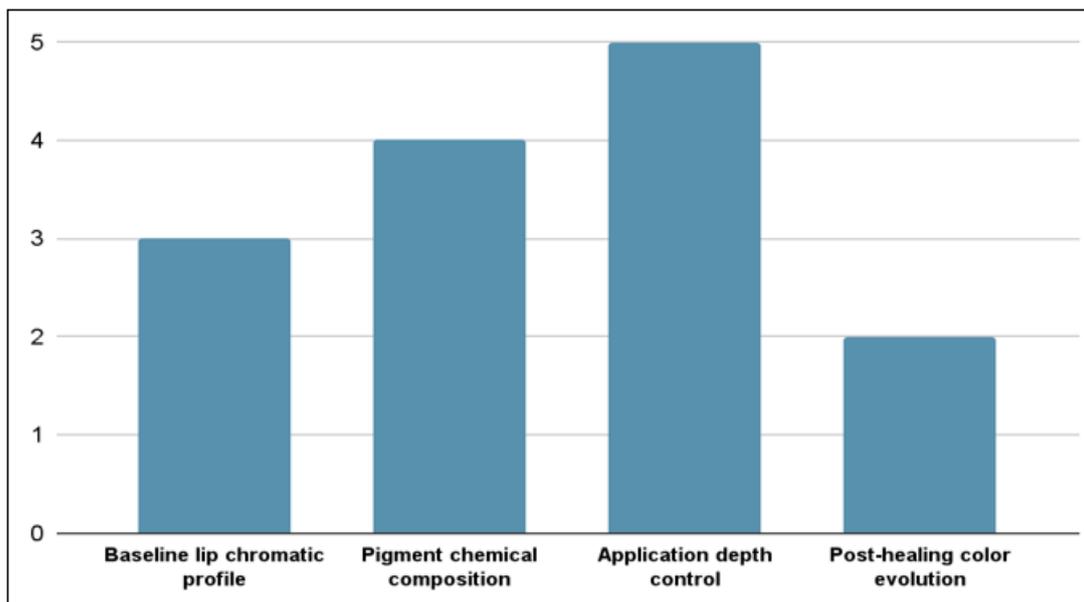


Figure 2: Relative contribution of major determinants to natural lip color outcome (compiled by the author based on [1–4])

The integration of spectral imaging and reflectance measurement in routine practice extends beyond aesthetic concerns, assisting in post-procedure evaluation to detect early inflammatory reactions and pigment instability. Legal regulations affecting pigment composition reinforce the necessity of using traceable pigment sources with documented compliance to chemical safety standards [4,7].

to physiological tissue characteristics, and long-term tonal planning grounded in pigment behavior in vivo. This approach replaces intuitive or visually based methods with standardized chromatic profiling, controlled pigment dosing, and verified dermal interaction patterns. The synthesized results confirm that pigment selection and controlled implantation depth jointly determine the visual naturalness and long-term chromatic stability of lip makeup.

Taken together, contemporary practice in permanent lip makeup prioritizes scientific monitoring of color, adaptation

4. Discussion

The analysis of modern approaches to coloristics in permanent lip makeup indicates that the achievement of natural shades requires a combined consideration of pigment chemistry, anatomical characteristics of the lip tissues, application depth, and long-term color behavior. The findings reviewed in the literature demonstrate that naturalness is not defined solely by the initial pigment selection but by the predictability of optical and biochemical changes occurring over time. In this respect, knowledge of lip color typologies based on objective spectral measurements provides a foundation for individualized planning. When natural lip colors were measured using hyperspectral and photographic imaging systems, distinct chromatic distributions were consistently observed between upper and lower lips, as well as across different participants. This suggests that technicians should calibrate pigment undertones relative to the client's baseline chromatic profile instead of relying on standardized color charts.

The importance of precise depth control during pigment implantation is emphasized by the relationship between scattering of visible wavelengths and dermal placement. When pigment particles are deposited deeper into the dermis, scattering accentuates shorter wavelengths, resulting in cooler or bluish undertones. This is particularly relevant for lip procedures, where even minor deviations in implantation depth can alter the intended warmth and saturation of the healed result. In procedures where pigments were inserted uniformly into the papillary dermis with controlled pressure and movement, color stability during the healing period demonstrated greater uniformity. In contrast, deeper or uneven placement was associated with gradual color dulling, patchiness, or tonal drift.

Pigment composition plays a determining role in both initial appearance and long-term chromatic behavior. Inorganic iron oxide pigments used extensively in lip procedures offer opacity and natural-diffused coverage, yet are prone to progressive oxidation, which can intensify red or rust-like hues after several months. This tendency highlights the need for anticipatory tonal correction, where cooler or neutral undertones are intentionally selected to counterbalance expected warm shifts. Organic pigments, while offering brighter and more intense color saturation, have smaller particle sizes and may diffuse more readily. Their stability under ultraviolet exposure, metabolic redistribution, and potential interactions with dermal macrophages introduce differing patterns of durability and fading. Therefore, the selection between inorganic and organic pigments- or their combination- must be guided by the desired visual effect, expected longevity, and the client's tissue characteristics.

Safety considerations remain central to modern coloristics. Chemical analyses of tattoo and permanent makeup inks have identified variable purity levels, including traces of heavy metals and residual industrial compounds. The presence of nickel, chromium, cobalt, or mercury introduces risks of allergic and inflammatory reactions, which may manifest immediately or after prolonged exposure. Regulatory frameworks have recently restricted the allowable concentrations of hazardous substances in pigments, yet

inconsistencies between manufacturing sources and labeling practices persist. Practitioners must therefore rely on certified pigment lines with transparent documentation and avoid cross-mixing formulas from different manufacturers, as differences in particle processing and carrier composition can lead to pigment instability, agglomeration, and unintended migration.

Maintenance and correction procedures form a necessary part of long-term lip coloristics. Because inorganic pigments gradually fade and undergo chromatic transformation, the most natural results are sustained through staged color refreshing rather than single high-density applications. This incremental approach aligns with the biological behavior of dermal macrophages, which continuously process and redistribute pigment particles over time. Techniques such as gradual layering, selective neutralization of emerging undertones, and controlled re-saturation preserve naturalness while minimizing the risk of over-pigmentation or abrupt tonal change.

Finally, the perception of naturalness is closely tied to the harmony between lip color and surrounding facial features. Subtle gradients that mimic the natural translucency of the vermilion and the softness of lip edges contribute to realism. Excessively sharp borders or uniform flat fills disrupt the physiological texture and create an artificial appearance. The integration of spectral lip measurement into consultation and planning improves the precision of shade matching and supports a more systematic approach to individualized color design.

In summary, contemporary coloristics in permanent lip makeup has shifted from intuitive pigment selection toward an evidence-based framework grounded in spectral analysis, pigment chemistry, dermal interaction, and controlled application technique. Achieving natural shades requires predicting the dynamic evolution of color in the skin, ensuring pigment purity and stability, and adapting color decisions to the client's unique chromatic and anatomical profile. This holistic approach enhances both aesthetic outcomes and long-term satisfaction while reducing the likelihood of visible tonal distortion or adverse tissue reactions. Thus, the integrated framework of color measurement, pigment chemistry, and dermal technique establishes a reproducible model for achieving natural and safe lip coloration.

5. Conclusion

The formation of natural lip shades in permanent makeup is determined by the interplay of baseline lip chromatic characteristics, pigment chemical composition, dermal implantation depth, and long-term color evolution. Instrumental spectral measurement supports accurate tone matching and enables personalized pigment selection aligned with individual tissue properties. The distinction between inorganic and organic pigments is essential for predicting fading behavior and chromatic stability, while regulatory and compositional transparency remains central to safety assurance. Controlled application depth and staged correction procedures contribute to maintaining translucency and preventing tonal distortion over time. The results of the study confirm the need for an evidence-based, individually oriented

approach, which replaces intuition-driven pigment selection with structured chromatic planning and scientific evaluation of materials. This approach promotes improved aesthetic outcomes and greater long-term client satisfaction.

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