# An Overview of Foundation Make-up for Diverse Skin Tones

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abstract

Many cosmetic brands have recognised the needs of consumers of diverse skin tones, who represent many nationalities and backgrounds. Yellow, brown, yellow-brown or reddish brown skin tones are part of the same single category of foundation make-up that has always existed. Developing a strategy for extending the boundaries of shading to address a wider range of colour is necessary, especially as demographics change.

Certain pigments and powders can be too white or opaque, or do not match a specific hue or undertone for Hispanic, Asian, Indian, African and Native American skin. The end result may lead to an appearance that is not perceived as natural. This article focuses on the selection of pigments and powders that will help the cosmetic formulator to create a diverse shade palette to address the needs of ethnic skin tones.

## Introduction

One of the leading segments for the beauty industry is the expanding market for multicultural or ethnic products. In recent years, demand for multicultural beauty products has grown rapidly. The market for this sector is expected to become even more diverse. Combined with the growth of interracial couples, there are new possibilities for cosmetic products, such as foundation make-up.

The number of Americans of mixed race grew by 32 % from 2000 through 2010. Multicultural beauty products are outpacing the growth of the overall market for cosmetics and toiletries.

The millennial generation, those born between 1980 and 2005, are characterised by their ethnic and cultural heterogeneity. A high number of millennials are immigrants or children of immigrants. There have been predictions that minority birth rates will surpass those of Caucasians, who will no longer be the majority in the United States by 2043. Forecasts say that in 2050, Hispanics will account for 28 % of all the US population, African Americans for 17 % and Asians for 8 %. Around the globe, countries are more homogeneous and less heterogeneous.

Therefore, products are needed to address consumers' individuality. For example, a cosmetic company created a foundation make-up with 22 shades to match a tonal palette that would represent all women globally.

This took nine years of research, measuring over 7,000 women all over the world [1]. They computerised 700 virtual shades that gave the widest cross-section and simplified the range to 22 final choices that represented the global palette.

Developing global products requires studying and researching a range of hair and skin types with different characteristics. Variation in pigmentation requires the collection and analysis of consumer data. It requires an understanding of the heritage of different races.

In addition to physiological needs, one benefit of multicultural beauty is that multicultural companies are more inclined to also meet the cultural, religious or philosophical needs of the market they are attempting to attract, such as Halal, Kosher or Hindu. The common thread running through this multicultural segment is that the ingredients in the formulation and packaging do not contain animal ingredients and are not tested on animals.

## Identifying the Key Issues

Ethnic products may require greater investment by a company's consumer and market research teams, as well as additional resources for R&D. Formulations can be more complex than in the past. [2]

Understanding the needs of women of different heritage and colour is essential. The variety of makeup routines reflects ethnic origin and cultural heritage, determining whether a woman feels positive towards her natural skin colour. For many women, skin colour is a major factor in their cultural identity [3]. Foundation make-up must be formulated to meet these specific needs.

Twenty years ago, major companies may have had a line of 12-15 shades to encompass all types of skin tones. Now these same companies have a separate ethnic line that may cover 12-15 shades, in addition to one for Caucasian skin.

They have realised the diversity and complexity within the ethnic segment of the marketplace and are responding to consumer needs.

## Undertones

The skin's surface tone is the colour that can be seen on the surface of the skin. The skin's undertone is the colour beneath the surface. A person may have the same skin colour as someone else, but a different undertone. Undertone is determined and affected by physiology. Skin is composed of various types of cellular-level elements: cells, fibres and chromophores are of special relevance to us. This is because light scattering and absorption in these fundamental elements are the building blocks of the gross optical phenomena observed at the cellular level.
Skin includes various types of light-absorbing chemical compounds called chromophores. Among these chromophores, melanin and hemoglobin are especially important for understanding the appearance of normal skin because they absorb light particularly in the visible wavelength.
On the other hand, scattering is caused mainly by fibres, cells or cellular organelles. Absorption and scattering at this cellular level will serve as the building blocks of light transport at the higher levels. [4]

Undertones are in the categories:

- cool (pink, red or bluish undertones),
- warm (yellow or golden undertones) and
- neutral (a mix of warm and cool undertones). Some include olive as a separate, fourth category, but most consider it neutral because it has a mix of warm and cool undertones.

This simply helps us narrow the search when trying to zero in on the right foundation shade. You then choose the light, medium, or dark version of that shade.

## Texturizing Agents for the Skin

Colour must be imparted in the correct balance for different skin tones. It is equally important to understand that people from different backgrounds have other issues related to their skin that also need to be addressed. Some skin (e.g., African-American skin) contains less moisture. Pore size also varies among races.
Texturing agents can help to provide smoothness to the skin, fill in lines and wrinkles, and add moisturisation, brightness, soft focus and optical effects to the skin. Nylon powders improve application onto the skin, while silica or polymer beads create a soft focus effect upon the skin. Multi-coloured pearlescent pigments can create shimmering tonal effects on the skin.
Microspheres with a high degree of porosity absorb oil (sebum) from the skin, thereby improving its overall finish throughout the day. These microspheres, classified as sebum control powders, can take care of excessive sebum and oil to suppress greasiness and produce a shine-free effect. Importantly, they also aid in application of the make-up onto the skin because of their ball-bearing effect.

## Pigments for Diverse Shades

Micronised dispersions of colour and sunscreen pigments are needed to provide colour while optimizing the coverage and optimising the degree of opacity to fit the skin type.
For facial foundations, inorganic pigments are generally used. These pigment dispersions consist of surface-treated pigments milled together with a dispersant and a liquid silicone, water, ester, or an oil. These dispersions may be chosen based on their compatibility with the overall system.
Surface treatments will enhance the dispersibility and stability of these colours in solvents, oils and esters.
Iron oxides are suitable for formulation and can be found in all shades of foundation make-up, from the lightest to the very dark tones. Product development formulators balance the colours using computer software linked to a spectrophotometer, as well as by visually evaluating the shades to match the specific target. Titanium dioxide is also widely used as the primary white pigment to achieve colour balance and opacity. Zinc oxide is a further option.
In addition, transparent iron oxide pigments, sometimes considered as special effect pigments, are those that possess a high degree of transparency in liquids when the difference between the refractive indices of the pigments and the medium is very low. The particle size of the pigment must be less than 0.2 microns to achieve transparency. This is accomplished during synthesis by the use of additives to prevent re-agglomeration of the pigment particles [5]. Therefore, they are effective in providing colour to the skin, but allowing ethnic skin tones to prevail when formulated correctly. Formula KLF-049B at the end of this article illustrates a foundation make-up containing transparent iron oxides. (**Fig. 1**)


**Fig. 1** Transparent red iron oxide ground into a dispersion with caprylic/capric triglyceride Magnification @100X

Transparent iron oxides are typically considered to be nanoscale pigments, in the same way that titanium dioxide and zinc oxide have sunscreen properties when incorporated as nanoparticles.
As particle sizes become smaller, their chalky appearance becomes less and less noticeable provided that the particles are small enough and their concentration in the final product is not too high. Generally, as the particle size becomes much smaller than the wavelength of visible light, particles become invisible. Because of their transparency, these pigments would allow more complex, darker skin tones to shine through the foundation make-up, giving a more natural colour appearance.
Transparent red iron oxide ($Fe_2O_3$), transparent yellow iron oxide ($Fe_2O_3 \cdot xH_2O$) and transparent black iron oxide ($Fe_3O_4$) may be used in combinations to achieve desired hues within the light-to-dark shade ranges. [6]
Ultramarine pigments can be used in foundation make-up formulations. Ultramarine blue may be used either to supplement or replace black iron oxide in specific shades where a more vibrant, darker tone is essential. Black iron oxide tends to look dull on skin, whereas ultramarine blue gives it a lift. Because of ultramarine blue's low refractive index, it has a high degree of transparency and becomes very dark when paired with oils or esters that are close to its refractive index.

## Compositional Colour Balance

Many foundation products now include an SPF with sunscreen actives. Both pigmentary and nano-sized pigments of titanium dioxide and zinc oxide may be included together in these formulations.

Titanium dioxide ranges from about 3-10 %, while zinc oxide, which is used less frequently, though present in many of the cushioned foundations from Korea, can range from 1-10 %. For Caucasian shades, 8-10 % titanium dioxide (the higher end of the range) is used. Asian and Hispanic shades use 5-6 % titanium dioxide and African-American shades are at the lower end of the range (3-4 % or less). Other inorganic colours are incorporated in all foundation make-ups:

1. Yellow iron oxide levels range from approx. 0.30-3.00 %.

2. Red iron oxide from 0.20-1.50 %.

3. Black iron oxide from 0.10-1.00 %.

4. Ultramarine Blue from 0.05-0.50 % or more.

As described in the next paragraph, other fillers and microspheres are more transparent or translucent. They can supplement, and may better address, the needs of the darker shades.

## Transparency and Opacity

Transparency is the physical property of allowing light to pass through the material without being scattered. Transparency is a key physical property in the development of ethnic shades and colours. Opacity, transparency and translucency need to be carefully engineered, because foundation make-up products can be too chalky on ethnic skin.
The overall concentration and transparency/opacity value of pigments and powders is important for delivering the unique benefits to the consumer. By creating a more transparent or translucent film through the matching of refractive indices, some light is able to pass through some of the particles more easily, allowing other surfaces to interplay for complex colour effects.
The transparency of pigments increases with the following properties: lower refractive index, fineness (until optimal size is reached), lightness of colour and, in certain cases, the topography and complexity of the pigment.
We measured the contrast ratio of over 30 raw materials. Contrast ratio is a measure of transparency/opacity of an ingredient or a formulation. This property is measured with a spectrophotometer by obtaining the ratio of Black Y/White Y. (see **Fig. 2**.) We made five measurements for each material tested, and then

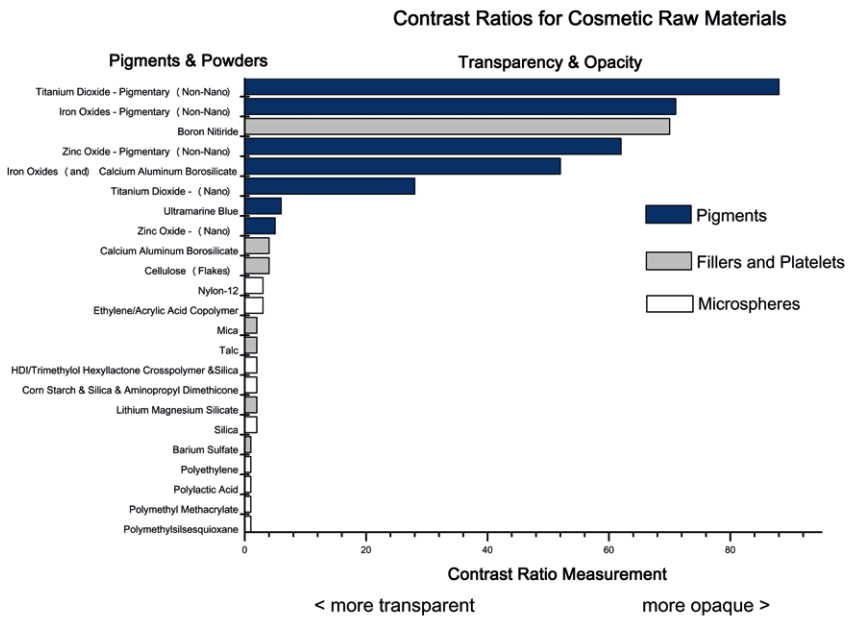


**Fig. 2** Transparency/opacity measurements of wet films cast from pigment or powder dispersions. Concentration - 10 % solids in jojoba oil

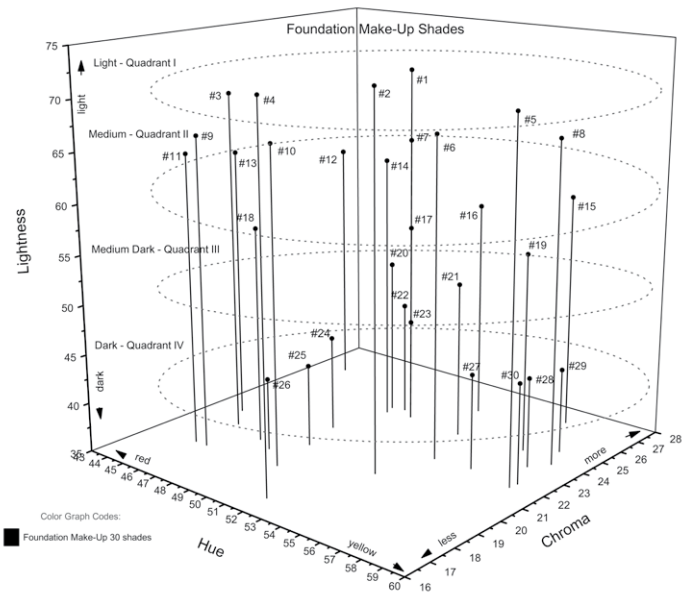


**Fig. 3** Colour mapping of an extended shade range that includes tones for Hispanic, Asian, African-American and Caucasian skin

took the average. As illustrated in the graph for contrast ratios above, we made a series of pigments and powders that we dispersed in jojoba oil. This is a commonly used oil, especially within the natural products category. Its refractive index (1.46) closely matches that of some of the powders and pigments. It helps provide transparency to the materials dispersed in it.

It is important when formulating foundation products to consider the surrounding medium in which the pigments and powders are dispersed.

To maximise transparency for some shades of ethnic skin where you want to allow the woman's skin tone to shine through, you need to select the oil or ester that is compatible with the pigments and powders and will not separate from the matrix upon application onto the skin.

From the chart above, we observe that microspheres as a class of materials are essentially transparent when dispersed in the right medium.

Additionally, a number of fillers, such as barium sulphate and lithium magnesium silicate, are also very transparent. Talc and mica (muscovite), the most commonly used fillers, have good transparency and are also relatively inexpensive. Biotite is a filler that combines the properties of mica with iron oxides. It is sometimes called "iron mica" because it is more iron-rich than magnesium mica. It is also sometimes called "black mica" as opposed to "white mica" (muscovite).

The remaining microspheres and fillers are translucent, with the exception of boron nitride, which is opaque, owing to its high refractive index (1.74 -1.80). Boron nitride, because of its opacity, can be used to improve all shades by replacing titanium dioxide or zinc oxide at varying levels. It has excellent cosmetic properties because of its hexagonal plate structure, similar to the well-known lubricant, graphite.

The inorganic pigments vary in opacity depending on particle size and chemistry. Ultramarine blue and other ultramarines are translucent, as is nano-sized zinc oxide. Nano-sized titanium dioxide is of low opacity, especially when compared with pigmentary particles of the same size.

## Colour/Shade Mapping

In the chart above, we provide an example of how an extended shade range might look when mapped out in LCH colour space.

We measured a number of products that are currently in the marketplace. Quadrant I represents the very lightest shades of makeup, those that would fall into the Ivory category, primarily for Caucasian skin. They are generally lower in chroma and have a high lightness value. Quadrant II represents more medium light and natural shades, also for Caucasian skin. They have higher chroma than the light shades, with a wide range of hues, but the lightness/darkness value is lower than in Quadrant I.

Quadrant III contains slightly darker shades, with more chroma and a somewhat more yellow hue, appealing more to Hispanic and Asian skin tones. They are darker than Quadrant I and II. Quadrant IV represents the darkest tones, which are more suitable for African-American skin. These are generally higher in chroma and may lean to either yellow or red in hue.

## Formulations (examples on page 36-37)

### KLF-049B

A UVA/UVB-balanced foundation make-up for ethnic skin. It incorporates transparent iron oxides and a micronised titanium dioxide dispersion.

### KLF-120-BR

A cream-textured foundation using elastomers and a fused titanium dioxide along with colour dispersions. Its shade works for tan skins and even yellowish undertones with fair skin.

## Conclusion

Ethnic shade lines can be separately marketed, but are generally considered to be well integrated into the foundation make-up category. Shade selection is of great importance to the consumer. Providing point-of-sale aids with samples, specific coding for shades, colour matching or literature can better educate the consumer. Knowledge of skin undertones can enhance customers' selection of shades. Foundation lines that offer a wide variety of shades are likely to fit a higher percentage of skin types and tonal variations.

Understanding skin from a multicultural perspective will enable cosmetic companies to achieve their technical targets and satisfy a broader category of consumers with a global shade palette. Selecting pigments at the correct levels and with corresponding needs, such as UVA/UVB balance, can help to deliver products with optimal colour and additional suncare benefits.

Microspheres and fillers are important to foundation make-up for providing texture and application. Ingredients such as silica, ethylene/methacrylate copolymer, nylon, polymethyl methacrylate and elastomers can deliver benefits to the skin to preserve the finish and create a soft glow through light diffusion.

### Kobo Blendable Foundation with Transparent Iron Oxides, KLF-049B

| Part | Ingredients | INCI Name | % |
|---|---|---|---|
| 1 | X-22-6711D | Dimethicone (And) PEG/PPG-18/18 Dimethicone | 4.80 |
| | SS4267 | Dimethicone (And) Trimethylsiloxysilicate | 2.50 |
| | Lexol® PG-865 | Propylene Glycol Dicaprylate/Dicaprate | 2.30 |
| | SALACOS® 99 | Isononyl Isononanoate | 2.00 |
| | Ethyl Alcohol E1028 | Ethyl Alcohol | 1.00 |
| | SUMECTON SAN-P | Quaternium-18 Hectorite | 1.00 |
| | SF1555 | Bis-Phenylpropyl Dimethicone | 0.75 |
| | KF-6017 | PEG-10 Dimethicone | 0.50 |
| 2 | CSF-3100@5cSt | Dimethicone | 16.60 |
| | TNP40VTTS | C12-15 Alkyl Benzoate (And) Titanium Dioxide (And) Alumina (And) Polyhydroxystearic Acid (And) Isopropyl Titanium Triisostearate (And) Triethoxycaprylylsilane | 9.40 |
| | TNP55TRY | Iron Oxides (C.I. 77492) (And) C12-15 Alkyl Benzoate (And) Triethoxycaprylylsilane (And) Polyhydroxystearic Acid | 4.05 |
| | TNP55TRR | Iron Oxides (C.I. 77491) (And) C12-15 Alkyl Benzoate (And) Triethoxycaprylylsilane (And) Polyhydroxystearic Acid | 3.55 |
| | SW65U | Synthetic Wax (And) Titanium Dioxide (And) Isopropyl Titanium Triisostearate | 2.10 |
| | KF-6017 | PEG-10 Dimethicone | 1.50 |
| | TNP80BNFSI | Iron Oxides (C.I. 77499) (And) C12-15 Alkyl Benzoate (And) Triethoxycaprylylsilane (And) Polyhydroxystearic Acid (And) Trihydroxystearin | 1.20 |
| 3 | Deionised Water | Water | 37.50 |
| | Butylene Glycol | Butylene Glycol | 2.00 |
| | Glycerin USP (96 %) | Glycerin | 1.25 |
| | Germaben® II | Propylene Glycol (And) Diazolidinyl Urea (And) Methylparaben (And) Propylparaben | 1.00 |
| | Sodium Chloride | Sodium Chloride | 1.00 |
| | Jeecide CAP-5 | Phenoxyethanol (And) Caprylyl Glycol (And) Potassium Sorbate (And) Water (And) Hexylene Glycol | 0.50 |
| | Tween™ 20 | Polysorbate 20 | 0.50 |
| 4 | MSS-500W | Silica | 3.00 |
| **Total** | | | **100.00** |

**Manufacturing Procedure**
1. Homogenise all ingredients of Part 1 until fully dispersed. Homogenise at least 20 minutes at 3000 rpm.
2. Add Part 2 to dispersed Part 1 at room temperature. Homogenise for 15 minutes.
3. Slowly add Part 3 to dispersed Parts 1 and 2 at room temperature and homogenise until dispersed.
4. Add Part 4. Continue homogenisation for 10 minutes. Fill into containers.

**Formulation 1** Kobo Blendable Foundation with Transparent Iron Oxides, KLF-049B

Transparency and opacity are tools that the product development formulator can use to further optimise foundation make-ups. Cosmetic scientists can help to engineer better products for all types of skin by designing matrices with various particles, refractive indices, and the surrounding mediums to help achieve innovative products.

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### Kobo Whipped Cream Foundation, KLF-120-BR

| Part | Ingredients | INCI Name | Percent |
|---|---|---|---|
| 1 | Deionised Water | Water | 38.27 |
| | Sodium Chloride | Sodium Chloride | 0.75 |
| 2 | Glycerin | Glycerin | 3.50 |
| | NOMCORT® AG | Agar (And) Xanthan Gum | 1.00 |
| 3 | Silsoft 034 | Caprylyl Methicone | 8.00 |
| | $TiO_2$ FX-50-I2 | Titanium Dioxide (And) Aluminum Hydroxide (And) Isopropyl Titanium Triisostearate (And) Iron Oxides (C.I. 77491) | 6.00 |
| | SALACOS® 99 | Isononyl Isononanoate | 5.00 |
| | SF1540 | Cyclopentasiloxane (And) PEG/PPG-20/15 Dimethicone | 4.00 |
| | CPF-3200@350cPs | Diphenyl Dimethicone | 3.00 |
| | Syncrowax BB4-PA-(RB) | Synthetic Beeswax | 2.00 |
| | BTD-FS | Titanium Dioxide (And) Perfluorooctyl Triethoxysilane | 2.00 |
| | NOMCORT® HK-G | Glyceryl Behenate/Eicosadioate | 2.00 |
| | CFF-3400@12,500cPs | Trifluoropropyl Methicone | 2.00 |
| | Liposorb® O | Sorbitan Oleate | 1.00 |
| | BWYO-FS | Iron Oxides (C.I. 77492) (And) Perfluorooctyl Triethoxysilane | 0.20 |
| | BWRO-FS | Iron Oxides (C.I. 77491) (And) Perfluorooctyl Triethoxysilane | 0.20 |
| | BWBO-FS | Iron Oxides (C.I. 77499) (And) Perfluorooctyl Triethoxysilane | 0.08 |
| 4 | Silsoft Silicone Gel | Cetearyl Dimethicone/Vinyl Dimethicone Crosspolymer (And) Cyclopentasiloxane | 10.00 |
| | Velvesil DM | Dimethicone (And) Cetearyl Dimethicone Crosspolymer | 5.00 |
| | Optiphen | Caprylyl Glycol (And) Phenoxyethanol | 1.00 |
| 5 | SP-10 | Nylon-12 | 5.00 |
| **Total** | | | **100.00** |

**Manufacturing Procedure**
1. Combine Part 1 and heat to 70 °C.
2. Combine Part 2 ingredients into a slurry and add to Part 1 while mixing.
3. Combine Part 3 and heat to 70 °C.
4. Add Parts 1 and 2 into Part 3 under homogenisation.
5. Add Parts 4 and 5 while cooling.
6. Cool to 45 °C and fill into components.

**Formulation 2** Kobo Whipped Cream Foundation, KLF-120-BR