Purpose: The purpose of this experiment is to determine the effectiveness of five popular foundations on the current market that advertise solutions for hyperpigmentation, hypopigmentation, & general uneven skin. We will test these foundations on the facial skin using light spectroscopy and other instrumentation in order to determine percent of even coverage. The results will be used to create a new foundation that increases this effectiveness using similar ingredients with a focus on natural and clean products.

The transmission, absorption and reflectance spectrum of each foundation was obtained from thin films of various thickness using UV-Vis spectroscopy together with the reflectance and absorption spectra of facial skin of various pigmentation, with a spot size resolution of 2 x 2 mm both with and without foundation of various thicknesses. The spectra of individual compounds and pigments in each foundation was also observed. The spectra of bare skin and foundation as pure thin films was overlaid and compared to the spectra of skin with foundation. This allowed identification of the most appropriate pigment combinations to be used to create formulations for maximizing the degree of uniform coloration of specific skin types. The data was used to create a model allowing *a priori* prediction of color uniformly of specific subjects with a measured performance confidence of Y.

Foundations:

| Name | Type | Claims | Ingredients |
| --- | --- | --- | --- |
| Too Faced Born This Way Foundation | liquid | * Blurs imperfections * Hydrating * Long-wearing | Water/Aqua/Eau, Cyclopentasiloxane, Glycerin, Aluminum Starch Octenylsuccinate, Isododecane, Polyglyceryl-4 Isostearate, Cetyl -10/1 Dimethicone, Hexyl Laurate, Dimethicone, 1,2-Hexanediol, Alcohol, BHT, Butylene Glycol, Caprylyl Glycol, Cocos Nucifera (Coconut) Water/Cocos Nucifera Water, Diphenyl Dimethicone, Disteardimonium Hectorite, Ethylhexyl Methoxycinnamate, Ethylhexyl Palmitate, Hexylene Glycol, Lecithin, Magnesium Sulfate, Phenoxyethanol, Pistacia Lentiscus (pore size) (Mastic) Gum/Pistacia Lentiscus Gum, Polysilicone-11 (film), Potassium Sorbate, Propylene Carbonate, Rhododendron Ferrugineum Extract (protectant/mask), Silica Dimethyl Silylate, Sodium Hyaluronate, Tetrahexyldecyl Ascorbate (vitamin c), Tetrasodium EDTA, Tribehenin, Triethoxycaprylylsilane, Iron Oxides (CI 77491, CI 77492, CI 77499), Titanium Dioxide (CI 77891). |
| Essence Keep Me covered Long- lasting foundation | liquid | The super soft formula provides medium to high coverage and seamlessly melts into the skin, giving your complexion an even, healthy look for up to 16 hours! Pair with the Keep Me Covered Concealer for flawless-looking skin. Available in 20 universal shades, this foundation is sure to keep you looking flawless all day long. | AQUA (WATER), ISODODECANE, C13-15 ALKANE (emollient), POLYGLYCERYL-4 DIISOSTEARATE/POLYHYDROXYSTEARATE/SEBACATE, C12-15 ALKYL BENZOATE, ZINC STEARATE, PROPANEDIOL, MAGNESIUM SULFATE, PENTYLENE GLYCOL, TOCOPHEROL, ETHYLENE BRASSYLATE, 1,2-HEXANEDIOL, DISTEARDIMONIUM HECTORITE (thickening), CAPRYLHYDROXAMIC ACID, SILICA, LECITHIN (emulsifer = smooth), PROPYLENE CARBONATE, STEARIC ACID, SODIUM CHLORIDE, ASCORBYL PALMITATE (antioxidant/perservative), ALUMINUM STARCH OCTENYLSUCCINATE (anti-caking agent), CITRIC ACID, CI 77491 (IRON OXIDES), CI 77492 (IRON OXIDES), CI 77499 (IRON OXIDES), CI 77891 (TITANIUM DIOXIDE). |
| Fenty Beauty Pro Filt’r Soft Matte Longwear foundation | liquid | * Longwear, shine-free, soft matte finish * Features Climate Adaptive Technology that flexes with your skin in every environment to absorb oil instantly, reduce shine and leave a matte finish. Non-drying, and sweat- and humidity- resistant. * Instantly smooths and diffuses the look of pores * Light as air and undetectable on skin so you always look like you * Noncomedogenic * Available in 50 shades | AQUA/WATER/EAU, DIMETHICONE, TALC, PEG-10 DIMETHICONE, TRIMETHYLSILOXYSILICATE, POLYPROPYLENE (humectant= increase moisture), ISODODECANE (moisture), CETYL PEG/PPG-10/1 DIMETHICONE  (create stable emulsions), NYLON-12 (reduces shine/ silky skin), HDI/TRIMETHYLOL HEXYLLACTONE CROSSPOLYMER (enhances slip), PHENOXYETHANOL, SODIUM CHLORIDE, HYDROGEN DIMETHICONE, GLYCERIN, MAGNESIUM SULFATE, SODIUM DEHYDROACETATE, DISTEARDIMONIUM HECTORITE, ALUMINUM HYDROXIDE, METHICONE, BENZOIC ACID, DEHYDROACETIC ACID, PROPYLENE CARBONATE, ETHYLHEXYLGLYCERIN, PARFUM/FRAGRANCE, SILICA, BIOSACCHARIDE GUM-4, PENTAERYTHRITYL TETRA-DI-T-BUTYL HYDROXYHYDROCINNAMATE, ANANAS SATIVUS (PINEAPPLE) FRUIT EXTRACT, CARICA PAPAYA (PAPAYA) FRUIT EXTRACT, PAULLINIA CUPANA SEED EXTRACT, POTASSIUM SORBATE, TOCOPHEROL, SORBIC ACID. MAY CONTAIN/PEUT CONTENIR (+/-): TITANIUM DIOXIDE (CI 77891), IRON OXIDES (CI 77491, CI 77492, CI 77499). |
| Sephora Matte perfection tinted moisturizer | liquid |  | Aqua (Water), Dimethicone, Talc, Ci 77891 (Titanium Dioxide), Silica, Cetyl Peg/Ppg-10/1 Dimethicone, Glycerin, Neopentyl Glycol Diheptanoate, Polymethylsilsesquioxane, Hdi/Trimethylol Hexyllactone Crosspolymer, Isododecane, Phenoxyethanol, Sodium Chloride, Ethylene Brassylate, Magnesium Sulfate, Dimethicone/Vinyl Dimethicone Crosspolymer, Sodium Dehydroacetate, Hydrogen Dimethicone, Potassium Sorbate, Quaternium-18 Hectorite (have -31), Benzoic Acid, Aluminum Hydroxide, Triethoxycaprylylsilane, Ci 77492 (Iron Oxides), Dehydroacetic Acid, Propylene Carbonate, Ethylhexylglycerin, Ci 77491 (Iron Oxides), Ci 77499 (Iron Oxides). |
| L’Oréal Paris 24 hr foundation infallible pro-glow | Liquid  Glycol, Alumina, Bht, Sodium Citrate, Tocopherol, Isopropyl Alcoho, Iron Oxides, Bismuth Oxychloride | Discover the new pro finish of longwear: up to 24 hour wear with a hydrating glow. Lightweight and creamy, this long lasting foundation goes on smooth with a glow finish that lasts. With medium coverage, it instantly hides imperfections for a clear complexion. The hydrating foundation with SPF is ideal for normal to dry skin. | Active Ingredients: Octinoxate 3.2% (Sunscreen)  Inactive Ingredients: Water, Cyclopentasiloxane, Alcohol Denat, Phenyl Trimethicone, Glycerin, Peg-10 Dimethicone, Bis-Peg/Ppg-14/14 Dimethicone, Dimethicone, Magnesium Sulfate, Ethylhexyl Hydroxystearate, Talc, Silica, Peg/Ppg/Polybutylene Glycol-8/5/3 Glycerin, Disodium Stearoyl Glutamate, Dimethicone/Polyglycerin-3 Crosspolymer, Polymethyl Methacrylate, Tocopheryl Acetate, Aluminum Hydroxide, Magnesium Stearate, Silica Silylate, Dipropylene Glycol, Alumina, Bht, Sodium Citrate, Tocopherol, Isopropyl Alcoho, Iron Oxides, Bismuth Oxychloride |
| Juvias palace I am magic velvety Foundation | liquid |  | WATER, DIMETHICONE, CYCLOHEXASILOXANE, BUTYLENE GLYCOL, BIS-PEG/PPG-14/14 DIMETHICONE, GLYCERIN, POLYMETHYL METHACRYLATE, SILICA DIMETHICONE/VINYL DIMETHICONE CROSSPOLYMER, C30-45 ALKYL DIMETHICONE, TRIMETHYLSILOXYSILICATE, SILICA DIMETHICONE SILYLATE, TRIETHOXYCAPRYLYLSILANE, SODIUM PCA, TOCOPHERYL ACETATE, SODIUM CHLORIDE, ALUMINUM HYDROXIDE, CYCLOPENTASILOXANE, PHENOXYETHANOL, SODIUM DEHYDROACETATE POTASSIUM SORBATE MAY CONTAIN IRON OXIDES |

MATERIALS AND METHODS

<https://www.nist.gov/programs-projects/reflectance-measurements-human-skin>

<https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4907617/>

Potential Devices

<https://www.amazon.com/gp/product/B09PZSWZW2/ref=ox_sc_saved_title_2?smid=A3O66F2NKGA477&th=1>

<https://www.amazon.com/dp/B0BGQMYJLS/ref=sspa_dk_detail_0?pd_rd_i=B084Z62KX3&pd_rd_w=a7NVs&content-id=amzn1.sym.d81b167d-1f9e-48b6-87d8-8aa5e473ea8c&pf_rd_p=d81b167d-1f9e-48b6-87d8-8aa5e473ea8c&pf_rd_r=J61Z419AKNJTJ4VB0X81&pd_rd_wg=NvjyI&pd_rd_r=6a89a92f-fc74-40e8-91ba-5cee37009967&s=hi&sp_csd=d2lkZ2V0TmFtZT1zcF9kZXRhaWxfdGhlbWF0aWM&smid=A1VOY3V4S1IGOF&spLa=ZW5jcnlwdGVkUXVhbGlmaWVyPUEzQkRXVE1LUDFDVVVEJmVuY3J5cHRlZElkPUEwMTcyMDg0MzFENUZYMzJDUFUwNiZlbmNyeXB0ZWRBZElkPUEwNjk5MDYxM0Y1T09VMTRaTlJJWiZ3aWRnZXROYW1lPXNwX2RldGFpbF90aGVtYXRpYyZhY3Rpb249Y2xpY2tSZWRpcmVjdCZkb05vdExvZ0NsaWNrPXRydWU&th=1>

<https://www.amazon.com/gp/product/B09PZHC75H/ref=ox_sc_saved_image_3?smid=A1VOY3V4S1IGOF&psc=1>

UV-Vis data acquisition.

What I put in the document I think must or possible from first principles, however, the biggest difficulty I see for use is going to be can we acquire the data in a consistent manner allowing the normalized data to be compared. I think I could make a machine if I have too. That is not a problem, just more time consuming. Usually this type of data is acquired in vitro and put in a light box. We need to do it point wise on your face.

There are 4 ways to approach this. I will draw a light diagram once we decide on one (Technically my academic courses and specialty in my phd courses is optical physics, I started working in nanomedicine when I realized the way I was trying to make new optical devices was using particles the same size as a virus.).

1. send the light down a fiber and collect the reflected light back up the same fiber using a beam splitter. This would also allow for monitoring the incident light for normalization. If reflectance signal intensity is not divided by the incident light we will have a hard time comparing things because most light sources have a lot of fluctuation in their intensity over time and at different wavelengths.

2. Use two separate fibers.

3. Use a mini spectrometer placed at the face and used to push the skin locally flat.

4. Focused beam reflection or passive reflectance.

Note: The fibers are the best choice because we can do them anywhere. We will have to acquire the data in item 2 or 4 in a dark room or use some kind of light shield. The incident light is not strong. It hits a grating, goes through a narrow slit and is actually hard to see with the eye even in relatively dark rooms.

Once everything is set up the data collection can be done in just a few days.

ChatGPT:

Creating a formula for a foundation that evens skin tone involves combining various ingredients that provide color correction, coverage, and skin-benefiting properties. Here's a general formula to give you an idea:

Foundation Formula for Even Skin Tone:

Phase A:

- 60% Water

- 5% Glycerin

- 2% Hyaluronic Acid

- 1% Dimethicone

Phase B:

- 8% Titanium Dioxide (for physical sun protection and color correction)

- 4% Iron Oxides (for color correction based on skin tone)

- 3% Silica Microspheres (to improve texture and fill fine lines)

- 1% Niacinamide (to brighten skin and even out tone)

- 1% Vitamin E (for antioxidant protection)

- 0.5% Allantoin (to soothe and calm the skin)

- 0.5% Panthenol (to moisturize and improve skin texture)

- 0.5% Preservative (to prevent microbial growth)

Phase C:

- 10% Emollient Blend (combination of oils and silicones for smooth application)

- 4% Dimethicone

- 3% Caprylic/Capric Triglyceride

- 2% Jojoba Oil

- 1% Squalane

Phase D:

- 5% Emulsifier Blend (to stabilize the formula)

- 3% Cetearyl Alcohol

- 1% Glyceryl Stearate

- 1% PEG-100 Stearate

Phase E:

- 0.5% Fragrance (optional, for scent)

Instructions:

1. Combine ingredients from Phase A (water, glycerin, hyaluronic acid, dimethicone) in a separate container and mix until well combined.

2. In a separate container, combine Phase B ingredients (titanium dioxide, iron oxides, silica microspheres, niacinamide, vitamin E, allantoin, panthenol, preservative) and mix thoroughly.

3. In a third container, combine Phase C ingredients (emollient blend) and mix well.

4. In a fourth container, combine Phase D ingredients (emulsifier blend) and mix until a creamy consistency is achieved.

5. Slowly add Phase A into Phase D while stirring continuously.

6. Add Phase B into the mixture from step 5 and mix until the color is evenly distributed.

7. Gradually add Phase C into the mixture while stirring continuously to ensure uniformity.

8. Optional: Add fragrance (Phase E) if desired and mix well.

9. Transfer the mixture into a suitable foundation container or bottle.

10. Allow the foundation to sit for a few hours to ensure proper emulsion and stability before use.

Please note that this is a general formula and may need to be adjusted based on specific ingredients, skin types, and desired results. It's always recommended to consult with a cosmetic chemist or formulation expert to ensure safety and efficacy.