Development of a nail polish with minerals as caring ingredients

KF205X DEGREE PROJECT IN POLYMER TECHNOLOGY, SECOND CYCLE

CAROLINE THUNSTEDT
ABSTRACT

This master thesis project is a cooperation between The Royal Institute of Technology, KTH, and [Redacted] Nordic AB with the purpose to develop a nail polish for the makeup brand [Redacted]. It is important that the nail polish contains a good choice of ingredients according to the rules and guidelines of [Redacted]. Qualities required are good coverage, short drying time and easy removal. The nail polish should be bio based to 80 % and include caring ingredients such as minerals and almond oil.

To state the good effects of using the developed nail polish, the surface of the nail has been studied using SEM, scanning electron microscope. The nail was painted with the nail polish with caring ingredients for four weeks and the results showed that a smoother surface was achieved. Also, the hardness of the nail polish has been investigated using an AFM equipped with micro indenter to find out that the hardness of the nail polish with caring ingredients was higher with caring ingredients than without.

Along with the nail polish, an organic and caring nail polish remover was developed. The remover is gentle towards the skin and nails and does not cause any dryness. To ensure that the nail polish and the remover are stable, stability tests were performed and the results showed that the formula is stable in heat, UV-light and cold.

To investigate the nail polish on different types of nail surfaces and gather general opinions on the nail polish, a group study was made to find out what potential customers think about the product and the response was good.

A market analysis has been made to create a selection of fifteen colors including a top coat and a base coat. The price of the nail polish was set to 89 SEK for bottle that contain 9 ml. The nail polish and the nail polish remover will be launched in February 2015.
SAMMANFATTNING


Även en nagellacksborttagning utvecklades under detta examensarbete för att på ett skonsamt och milt sätt kunna ta bort nagellacket. Den nyutvecklade nagellacksborttagningen är skonsam och förhindrar både nageln och huden omkring från att bli uttorkad. För att bevisa att både nagellacket och nagellacksborttagningen är stabil, utfördes stabilitetstester i kyla, värme, rumstemperatur och UV-ljus med godkända resultat.

En fokusgrupp tillsattes med tolv deltagare för att undersöka nagellacket på olika typer av nagelytor och för att samla in åsikter om nagellacket och överlag fick nagellacket ett fint betyg.

Efter genomförden markands- och prisanalys kommer serien innehålla femton färger (över och underlack inkluderat) och priset blir 89 SEK för nio ml. Nagellacken och nagellacksborttagningen lanseras för i februari 2015.
TABLE OF CONTENTS

ABSTRACT ............................................................................................................................................... 0
SAMMANFATTNING .......................................................................................................................... 1
1. INTRODUCTION ............................................................................................................................... 4
   1.1 AIM ............................................................................................................................................ 4
   1.2 THE COMPANY ....................................................................................................................... 4
2. MINERAL MAKE UP .......................................................................................................................... 4
3. COMPETITION ................................................................................................................................. 5
4. THE NAIL .......................................................................................................................................... 7
5. NAIL POLISH .................................................................................................................................... 7
   5.1 FILM THICKENER ..................................................................................................................... 8
   5.2 PLASTICIZER ............................................................................................................................ 8
   5.3 ADHESIVES ............................................................................................................................. 9
   5.4 COLOR ....................................................................................................................................... 10
   5.5 SOLVENT ................................................................................................................................... 11
   5.6 MAXIMUM AMOUNTS OF THE INGREDIENTS OF A NAIL POLISH ............................. 11
   5.7 MINERALS .............................................................................................................................. 11
6. NAIL POLISH REMOVER .............................................................................................................. 12
7. ......................................................................................................................................................... 12
   7.1 FORMULA .................................................................................................................................. 13
8. CARING INGREDIENTS .................................................................................................................. 13
   8.1 ALMOND OIL ........................................................................................................................... 13
   8.2 MINERALS FROM THE DEAD SEA ....................................................................................... 14
9. LABORATORY STUDY ..................................................................................................................... 14
   9.1 STABILITY TESTING ................................................................................................................ 14
## Development of a nail polish with minerals as caring ingredients

**Caroline Thunstedt**

<table>
<thead>
<tr>
<th>Section</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>9.2 SEM</td>
<td>14</td>
</tr>
<tr>
<td>9.3 INDENTATION</td>
<td>15</td>
</tr>
<tr>
<td>9.4 NAIL POLISH REMOVER</td>
<td>16</td>
</tr>
<tr>
<td>10. GROUP STUDY</td>
<td>16</td>
</tr>
<tr>
<td>11. RESULTS AND DISCUSSION</td>
<td>17</td>
</tr>
<tr>
<td>11.1 STABILITY TESTING</td>
<td>17</td>
</tr>
<tr>
<td>11.1.1 NAIL POLISH</td>
<td>17</td>
</tr>
<tr>
<td>11.1.2 NAIL POLISH REMOVER</td>
<td>19</td>
</tr>
<tr>
<td>11.2 HARDNESS TESTING</td>
<td>19</td>
</tr>
<tr>
<td>11.3 MORPHOLOGY</td>
<td>20</td>
</tr>
<tr>
<td>11.4 NAIL POLISH REMOVER</td>
<td>22</td>
</tr>
<tr>
<td>11.5 GROUP STUDY</td>
<td>23</td>
</tr>
<tr>
<td>11.6 MARKET ANALYSIS</td>
<td>24</td>
</tr>
<tr>
<td>12. THE FINAL PRODUCT</td>
<td>25</td>
</tr>
<tr>
<td>12.1 DESIGN AND COLORS</td>
<td>25</td>
</tr>
<tr>
<td>12.2 ECONOMIC ASPECTS</td>
<td>25</td>
</tr>
<tr>
<td>12.2.1 PRICING</td>
<td>25</td>
</tr>
<tr>
<td>12.2.2 IDUN MINERALS PRICES</td>
<td>26</td>
</tr>
<tr>
<td>13. ETHICS</td>
<td>27</td>
</tr>
<tr>
<td>14. SAFETY REPORT</td>
<td>27</td>
</tr>
<tr>
<td>15. FUTURE WORK</td>
<td>28</td>
</tr>
<tr>
<td>16. CONCLUSION</td>
<td>28</td>
</tr>
<tr>
<td>17. REFERENCES</td>
<td>29</td>
</tr>
</tbody>
</table>
1. INTRODUCTION

This master thesis is a cooperation between the makeup brand IDUN Minerals and the Royal institute of technology, KTH. IDUN Minerals makeup line consists of a variety of products including for example foundation, powder, lip gloss and eye shadow. There is no nail polish in the current selection of IDUN Minerals and consequently the cooperation was started. Nail polish is a large part of the cosmetic sector; hence a nail polish is a good complement to the IDUN Minerals selection.

1.1 AIM

The purpose of this master thesis was to develop a nail polish consisting of minerals according to the guidelines and rules of IDUN Minerals. The product should contain as few ingredients as possible with a high level of purity and also be easy to remove. The currently existing nail polishes in the market contain different types of solvents, adhesives and plasticizers. The purpose is to improve the currently existing formulas as much as possible but the main focus is the importance of caring qualities such as minerals and oils. The nail polish has to provide good coverage, dry fast and be easy to remove. Another goal for this master thesis was to develop a nail polish remover which would remove the nail polish gently, not cause dryness to the skin or nail and have a smart design.

The purpose of this master thesis was also to closely learn and study how a new product is developed. It is of interest to find out how to work from an idea to the final product and which steps along the way that needs to be made.

1.2 THE COMPANY

The company which the nail polish is developed for is Letsfaceit Nordic AB, a small company located in central Stockholm. The company has for many years been a distributor of cosmetics in Scandinavia but has during the last years developed its own make up brand, IDUN Minerals. The brand was first launched in April 2011 at Apoteket AB, the biggest pharmacy in Sweden. Since then, IDUN Minerals has grown a lot and is now sold in other pharmacies around Scandinavia and a few online stores.¹

2. MINERAL MAKE UP

It is beneficial to use mineral make up since the minerals let the skin breath. The skin is the largest organ of the body and the need for good products and taking good care of it is big. The molecules of the mineral make up are big enough to ensure that they will not be absorbed into the body and react further. Mineral make up has been used since the 1970’s and the most famous brand is bareMinerals who started the mineral make up industry. Since then, a lot of companies have developed their own mineral products. The quality and the price level vary a lot from different companies depending on how pure their products are. In general one could say that cheaper products have a lower rate of minerals and instead a lot of other ingredients such as filling components. These products cannot be classified as pure products. An example of a filling component is Bismuth oxichloride, a substance that can cause itch and irritation and is not used in IDUN Minerals products.² IDUN Minerals products are
100 % purified minerals and consequently the requirements for the product developed in this project are very high.

Some of the most common minerals in the powder and foundation products are zinc, mica, titanium and iron. All of them have certain qualities beneficial for the products. Since their qualities are good and caring for the skin they might be useful in a nail polish. The minerals soothe the skin and do not raise any allergies. The color in the foundations of [IDUN Minerals] originates from a series of Iron, Zinc and Titanium oxides and it is desired to use these in the nail polish as well. It is important that the colors are 100 % pure to avoid allergy towards nickel.

[IDUN Minerals] is a makeup brand consisting of 100% pure minerals appropriate for everyone, both with dry and oily skin. None of the products contain talc, oil, silicones perfume, bismuth or preservative. The products are free from water which helps to prevent microorganisms.

3. COMPETITION

It is important to look at the competition when developing a new product. Since [IDUN Minerals] is a rather small, high quality brand the major rivals are other mineral cosmetics brands with high quality. Also the other makeup brands sold in Apoteket AB (Swedish pharmacy) are classified as big rivals. In the list below one can find the biggest rivals.

- Id bareMinerals
- Jane Iredale
- Youngblood Mineral Cosmetics
- GloMinerals
- Tromborg
- Apoliva (Apoteket AB)

Out of the above mentioned brands, only the Danish make up brand Tromborg carry a nail polish in their product line. This nail polish is, according to their website described as:

Preservative is used in mascara and oil is used in the lip gloss and duo-concealer.
Tromborg’s nail polishes - just about nail care.

Filled with bioactive ingredients enriched from organic plant extracts, seawater algae and salt from the Dead Sea.

Contain also cold pressed Sun Flower Oil that regenerate and keep the nails in good shape as well as Wheat Germ Oil with high content of Vitamin E and Omega 3 and 6.

OPC’s from eco plants - the most potent plant antioxidants - take care of the Keratin, the main compound of nails structure so it is protected from attack of free radicals.

At the same time the OPC’s have wound healing and anti-allergen effects.

OPC = oligomeric proanthocyanadin

Biomagic!  

It can be seen that the nail polish from Tromborg includes a lot of protecting and caring ingredients. However, no extra minerals are added in the nail polish. This feature will distinguish the nail polish that will be developed for IDUN Minerals which is ideal since the minerals are the main focus of the IDUN Minerals product line. Otherwise, it seems like a good nail polish and it will be used as a reference during the laboratory study.

In 2013 a new makeup brand was launched at Apoteket hjärtat, the second largest pharmacy chain in Sweden. This brand is called Apolosophy and carries a nail polish in their line. However, this is not a caring nail polish and the price is only 39 SEK. Some pharmacies have also added the well-known brands Mavala and Depend to their selection. These brands are sold at low prices, but not known as caring products.

One competitive nail polish is the natural Acquaurella which uses water as a solvent. The problem with this polish is that it takes 10-15 minutes for the nail polish to dry. To many users, this is too long therefore only water as solvent is not an alternative.

Another nail polish that claims to be pure, at least to 85% is Kure Bazaar. This nail polish claims to be free from for example toluene and benzene with caring and natural ingredients. However, most nail polishes are free from these substances.

Caring nail products, available at the market currently, are most often colorless, treatment products. These products are supposed to be used in between the use of ordinary nail polish. The products, like for example nail oil, base coat and ridge filler, are often applied before the regular nail polish. Thus, a nail polish with different colors combined with caring minerals in the same product is somewhat unique.
4. THE NAIL

It is very common for women (and some men) to decorate and improve the looks of their nails. The nail is corresponding to the claws and hoofs of animals with the purpose to protect the toe- and fingertips. In the root of the nail cell division takes place which causes growth of the nail, the nail plate. The cells are only alive in the root of the nail. When they are pushed forward, they form the protecting nail and die. The normal growth rate is around 2-3 millimeter per month. The nail consists mainly of the protein keratin, a combination of glycine and arginine, which also can be found in hair and skin. There are also natural oils in the nail; most of them are cholesterol and squalene. The nail has also some mineral content including magnesium, calcium, iron, zinc, sodium, and copper.

5. NAIL POLISH

The scientists and developers of the different makeup brands develop the formulas constantly in order to minimize hazardous compounds and improve the formula. The general requirements of a nail polish are listed below.

- No damage towards skin or nails
- Easy to apply
- Dry fast (maximum 2 minutes)
- No coloration of the nail when the nail polish has been removed
- Provide even color with good coverage
- Provide shine
- Stable towards light
- The nail polish has to attach well to the nail and be stable towards mechanical load and tenside solutions since it can tear the nail polish off from the nail.

The currently available nail polishes are mainly produced from five types of ingredients; solvent, film thickener, plasticizer, adhesive and color pigment. A light stabilizer is often also added to protect the color from UV-light. Castor oil is often used in combination with an ester to help spread the color. The composition is different from polish to polish but the basic structure of the formula is similar. Most often, nitrocellulose is used as film thickener but other type of polymers can also be used in combination with the nitrocellulose. The different types of ingredients are more thoroughly described below.
5.1 FILM THICKENER
Nitrocellulose, the film thickener, is the main component in a nail polish. It creates a film on top of the nail, the structure, and holds all of the components together. Nitrocellulose is a cellulose derivative used in, besides nail polish, for example explosives but also as binders in printing inks and coatings. The nitrocellulose creates a hard film when applying the nail polish on the nail. It is important that the film is not formed too fast since the material underneath it has to dry. This makes nitrocellulose a good choice since it has the appropriate drying time. Another advantage with the nitrocellulose is that it is good at holding all the ingredients together. Nitrocellulose is a brittle compound and does not stick very well on top of the nail. Therefore other ingredients are needed to create a good nail polish. One can choose between different types of nitrocellulose since it is available with different viscosities depending on the molecular weight. A suitable solvent for nitrocellulose is ethyl acetate but other solvents need to be featured as well in order to lower the viscosity of the final product. The chemical structure of nitrocellulose is illustrated in figure 1.

![Figure 1 - The chemical structure of nitrocellulose](image)

5.2 PLASTICIZER
To increase the flexibility and the stability towards soap and water plasticizers and resins are used. A plasticizer is added to a polymer in order to soften it, in this case the nitrocellulose is too brittle to be used alone. The molecules in the nail polish are separated from each other when a plasticizer is used and due to this the van der Waals forces are decreased resulting in a more flexible material. There are many different plasticizers that can be used, no specific universal one. Phthalates are salts or esters from phthalic acid and are commonly used plasticizers. They are a much-discussed topic since they are cancerogenic and can cause health issues. They are nowadays forbidden in for example children toys. Most nail polishes do not contain these plasticizers anymore; instead the terpenoid camphor can for example be used. Camphor is a bicyclic ketone which for example is used in essential oils. Another commonly used plasticizer is triethyl citrate. The chemical structures of camphor and triethyl citrate are illustrated in figure 2 and 3.
5.3 ADHESIVES

Adhesives are very important ingredients in nail polish since they help the nitrocellulose to stick to the surface of the nail. The molecules in the adhesives are cross-linked covalently with the nail polish during the drying time; energy is needed in order for this to happen in the nail polish. The energy is taken from the nail and due to this the adhesive functions properly. The distance between the van der Waals forces between the molecules in the nail polish is larger than the length of the crosslinks created and therefore the film will shrink once the nail polish is applied. To ensure good adhesion, the adhesive needs a high enough molecular weight. A high molecular weight of the adhesive will result in a higher viscosity of the nail polish and therefore solvents are used to maintain balance. If lower molecular weight would be used the adhesion would consequently not be strong enough.\textsuperscript{22} Earlier the highly toxic compound formaldehyde was used to achieve adhesion. Nowadays tosylamide/epoxy resin (earlier tosylamide/formaldehyde resin) can be used instead. Another example of a commonly used adhesive is sucrose benzoate, which is illustrated in figure 4.\textsuperscript{23}
Development of a nail polish with minerals as caring ingredients

Figure 4 - The chemical structure of sucrose benzoate

5.4 COLOR

Necessary ingredients are also color pigments and light stabilizers. A commonly used light stabilizer is benzophenone, which protects the color of the nail polish by absorbing the UV-light and preventing the formation of free radicals. The chemical structure of benzophenone is illustrated in figure 5.

Figure 5 - The chemical structure of benzophenone

The colors used are different metal oxides which can be found naturally in the earth’s crust. Examples of colors used in nail polish are listed below.

- CI 77266 – Fe₃O₄ – Black
- CI 77491 – Fe₂O₃ – Red
- CI 77492 – FeO – Yellow
- CI 77891 – TiO₂ – White
- CI 77497 – ZnO – White
- Mica – Gives a nice and even tone to the skin.²⁴
5.5 SOLVENT

One of the problems with nail polish used today is, as previously mentioned, the solvent use. A solvent is a medium which dissolves a solute. It can either be solid or gas but most often it is a liquid. A solvent can either be organic or inorganic and the amount that can be dissolved depends on the temperature.

5.6 MAXIMUM AMOUNTS OF THE INGREDIENTS OF A NAIL POLISH

The maximum amounts of ingredients in a nail polish are listed below. 25

Table 1 - The maximum amount in weight% that can be used of a certain component in a nail polish

<table>
<thead>
<tr>
<th>Ingredient</th>
<th>Amount(%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ethanol and/or isopropanol</td>
<td>90</td>
</tr>
<tr>
<td>Solvent (i.e. ethyl acetate)</td>
<td>90</td>
</tr>
<tr>
<td>Film thickener</td>
<td>50</td>
</tr>
<tr>
<td>Plasticizer</td>
<td>15</td>
</tr>
<tr>
<td>Color</td>
<td>15</td>
</tr>
<tr>
<td>Other substances (i.e. vitamins, extracts, proteins)</td>
<td>10</td>
</tr>
<tr>
<td>Substances increasing the viscosity (i.e. silica)</td>
<td>5</td>
</tr>
<tr>
<td>Kamfer</td>
<td>5</td>
</tr>
</tbody>
</table>

5.7 MINERALS

IDUN Minerals is a mineral makeup brand and thus it is required to add minerals to the nail polish and prove the good effect.

Minerals are not only a fine powder used in cosmetics but also the building blocks of the earth, forming all big mountains and rocks. They normally consist of different elements but can also consist of one single element. Examples of these single element minerals are gold (Au) and diamond (C). Normally, these are pure but can sometimes be contaminated by impurities such as silver or copper. An example of a mineral with different elements is Halit (NaCl) which usually is referred to as normal salt.

Minerals usually present a well-coordinated, three dimensional, crystal structure. The shape and looks of the mineral grit is often similar to the crystal structure. One example is Quartz, SiO₂. If one let it grow freely it will form sharp and shiny crystals with a number of shiny and plane surfaces. The number of surfaces, their shape and angels between them is controlled by the inner crystal structure. Some
minerals, for example Opal, lacks the crystal structure but is still categorized as a mineral due to other qualities.\textsuperscript{26}

It is common knowledge that minerals have a good impact on people’s health. Usage of mineral make up presents a number of good minerals with positive effect onto the skin. An appropriate choice of minerals that could be added in the nail polish is listed below. The inspiration of some of the minerals originates from the minerals used in other IDUN Minerals products. It is not for sure that all of these will be used in the final product but they are suggested due to their good properties towards the nail.

- Zinc – Good for the well-being of the nail. Zinc is an antioxidant and prevents fragile nails.
- Silica – Strengthens the nail
- Selenium – A powerful antioxidant and good for the nail
- Calcium – Strengthens the nail
- Iron – Important for healthy nails\textsuperscript{27, 28}

The minerals are normally taken up by the body from food or drinks in the stomach and are then transferred further in the body where they can be used for their essential qualities. In mineral make up they act as caring ingredients towards the skin. For IDUN Minerals it was essential to include minerals in the nail polish and thus it was a requirement to investigate if the minerals can have a caring effect on the nail as well. As previously mentioned the nail is made out of keratin just like hair. This tissue is considered dead and it would be interesting to see if the minerals could help improve the nail in spite of this. As mentioned before, the nail contains traces of minerals and thus an addition of minerals was evaluated as suitable caring ingredients due to the already existence of minerals.

6. NAIL POLISH REMOVER

Once the nail polish should be removed a nail polish remover is used. For quick removal, acetone is a good choice since it instantly removes all traces of color. However, acetone is a solvent too strong to use on the nails and the skin around them since it causes dryness. Instead of acetone, many removers contain other solvents instead such as ethyl acetate or ethanol. Caring oils are sometimes added to make up for the dryness caused by the solvents.

Fiabila is a French nail polish manufacturer who provided this project with samples of nail polish in different colors as a suggestion of what a possible formula could be. The nail polish is 80% bio-sourced
Development of a nail polish with minerals as caring ingredients

2014-06-20

Caroline Thunstedt

and does not contain toluene, formaldehyde, phthalates or synthetic camphor. The ingredients are based of for example wheat, corn and potato. The nail polish consists of two plasticizers where one of them, according to the research and development department of Fiabila, is bio based, it is not known which of them it is. The nitrocellulose is 80 % bio based and several solvents have been exchanged for vegetable alternatives, which ensure fast dry. It is an advantage that part of the nail polish is bio based since the ingredients are manufactured from living organisms such as vegetables and plants.

7.1 FORMULA
The ingredients in the nail polish are listed below. Each of the ingredients is evaluated in the safety report in Appendix 4.

- ETHYL ACETATE
- BUTYL ACETATE
- NITROCELLULOSE
- ADIPIC ACID/NEOPENTYL GLYCOL/TRIMELLITIC ANHYDRIDE COPOLYMER
- ISOSORBIDE DICAPRYLATE/CAPRATE
- ALCOHOL
- N-BUTYL ALCOHOL
- ETOCRYLENE
- WATER
- CAPRYLIC/CAPRIC TRIGLYCERIDE
- PISTACIA LENTISCUS (MASTIC) GUM OIL
- TRIMETHYLPENTANEDIYL DIBENZOATE
- ISOMALT
- VIOLET 2
- LACTIC ACID
- PHOSPHOLIPIDS
- RHODODENDRON FERRUGINEUM LEAF CELL CULTURE EXTRACT
- SODIUM BENZOATE

8. CARING INGREDIENTS

The formula received from Fiabila is nice but in order for the nail polish to be unique some caring ingredients will be added which will make the nail polish caring towards the nail. The suggested ones are described below.

8.1 ALMOND OIL
Almond oil is caring oil compatible with both skin and nails. It contains the antioxidant vitamin E, which helps to avoid free radicals. This will be essential for the keratin since a protein can be destroyed from free radicals. The oil can be used as a natural makeup-remover in combination with castor oil since it does not harm or irritate the skin. When the nails or the skin around the nails is dry, almond oil can be used. As mentioned before the nail partly consists of oils. Adding oil to the nail polish will help the nail
Development of a nail polish with minerals as caring ingredients

from becoming dry and having cracks. Almond oil also contains the essential fatty acids omega 3 and omega 6 which prevent the nail from becoming too dry. Vitamin A and D is also included in the almond oil. The oil can also be used as a treatment in order to smooth damaged hair which gives an indication that the almond oil can be suitable for the keratin in the hair as well as the keratin in the nails. Moisture is an important quality for the nail and thus almond oil will be a suitable choice.

8.2 MINERALS FROM THE DEAD SEA

The essential minerals in the nail polish should originate from a natural source since 80 % of the nail polish is bio based. The Dead Sea is known for its high concentration of salt. The salt contains 26 essential minerals and due to this the salt is used in skincare due to their unique qualities. Some examples of the minerals are calcium, zinc, magnesium and potassium. The minerals can for example give a feeling of relaxation and nourish the skin. Other cosmetic products which have used minerals in their treatment products were investigated to find good inspiration. However, would like the nail polish be caring, not only create a treatment product. The minerals are supposed to fill in cracks of the nail in order to instantly strengthen and reinforce nails. The cracks will also not get bigger once the minerals have entered the crack. Since the Dead Sea salt consists of minerals this is the effect one will resemble using the Dead Sea salt.

9. LABORATORY STUDY

9.1 STABILITY TESTING

When a cosmetic product is developed it needs stability testing to ensure that the product is stable for a long time. The tests used in this master thesis project were recommended from . The formula was tested with the caring ingredients, both with and without color. The nail polish remover was tested using the same parameters.

- Heat (45° C) for four weeks
- Cold (4° C) for four weeks
- Room temperature for four weeks
- UV-setup for 30 hours

Approximately 0.5 ml of the sample, one fourth of the total volume of the glass vial, was added and then used for the stability testing.

9.2 SEM

In order to see how the nail polish manufactured affects the nail and helps to recover certain damage the surface of the nail was studied. This was done using SEM, scanning electron microscope, which uses a beam of electrons to produce an enlarged image of the sample. The electrons in the beam will interact with the atoms of the sample. This creates signals, which give information about the topography and composition. SEM was chosen for this project since the resolution is better than one nanometer to make sure that a structural difference can be seen. The analysis was performed in vacuum. The model, which was used, is called HITACHI S-4300 FE-SEM scanning microscope and is shown below in figure 6.
The first analysis was made on a nail that had not been treated with the caring nail polish. A part of the nail was cut off and then analyzed in the lab. In order to see what the natural state, the inside of the nail, looked like one made two samples. First, the inside (bottom) of the nail was analyzed and then compared with the surface of the nail. The surface is exposed to wear, mechanical load and various fluids such as water and tenside solutions to greater extent than the bottom. The bottom can be seen as the natural state and in this project it is of interest for the surface of the nail to resemble the bottom of the nail after usage of the nail polish for four weeks.

9.3 INDENTATION
An AFM equipped with micro-indenter was used to investigate the hardness of the sample to see how the formula was affected when adding caring ingredients to it. Indentation is a technique that uses a tip with load to measure the hardness of a sample. The model used was a CSM Instruments nano scratch tester equipped with an indenter with a Berkovich shaped diamond and evaluated using indentation software 3. It is important to measure the hardness of the sample since the nail polish has to be stable towards damage. Several tests were performed using this technique. To compare the hardness of the nail polish from IDUN Minerals with other nail polish brands, nail polish from Victoria’s Secret, Kiko and Tromborg were used. The AFM used in this project is shown in figure 7.
Figure 7 - The AFM equipped with micro indenter used for the hardness testing.

A sample of a basecoat nail polish containing around 0.1 weight% each of almond oil and Dead Sea salt was applied on plastic surface. Each nail polish was painted four times on the plastic surface with five minutes time to dry in between the applications. Also, the base coat, without caring ingredients, was applied on a plastic surface in order to be used as reference. The nail polish was investigated using a load of 1 N for testing the reference and the sample.

The reason for testing the nail polish on a plastic surface and not glass is that otherwise the hardness of the glass underneath the nail polish can be measured instead.

9.4 NAIL POLISH REMOVER

In a nail polish remover, oil can be used to protect the nail from the solvents used to remove the color. The solvent causes dryness of the nail and the oil helps to stabilize this and to moisture the nail. The bench product for this product development was SANTE, an organic nail polish remover which is gentle towards the nails. Using four different ingredients included in this product one would like to find the perfect combination that removes the nail polish in a gentle way. The ingredients used were:

- Alcohol
- Ethyl lactate
- Castor oil
- Water

The ingredients are much gentler than in other nail polish removers which contain stronger solvents. Also, the castor oil gives moisture to the nail and creates a smooth surface of the nail. The ingredients were added during stirring using a magnetic stirrer in a glass beaker and heated slowly to 50°C.

10. GROUP STUDY
A group study is often performed when a cosmetic product is to be launched to find out what is good with the product and what needs to be improved. A group study was performed with 12 women who got to test the nail polish with and without caring ingredients. The purpose was to evaluate the nail polish in general and also to find out if there was any difference between the two formulas. The participants received formulas marked with number one and two so that they would not know which formula was which. All the questions for the group study can be found in appendix 2.

The women participating in the group study were between 21 and 50 years old. The average age of the customers are around 25-55 years old. Thus a difference in age of the women testing the nail polish was needed. The participants normally purchase nail polish from 30 – 120 SEK and the most frequently used brands are Essie, OPI, Mavala, MakeUp Store and Depend.

11. RESULTS AND DISCUSSION

11.1 STABILITY TESTING
The stability testing of both the nail polish remover and the nail polish was successful. The suggested test parameters received from were used and the results for the nail polish and the nail polish remover are presented below.

11.1.1 NAIL POLISH
The stability testing in storage of 4°C showed that the formula with caring ingredient was not affected. The pigments did not divert from the rest of the solution due to the cold after four weeks. Also, the room temperature stored samples showed good results. The formula had not been affected from the caring ingredients. The result is shown in figure 8.
Figure 8 – The samples with caring ingredients after four weeks stored in cold. It can be seen in the picture that the bottles both contain 0.1 weight% of caring ingredient. The clear formula did not change color and the pigments in the right formula have not diverted from the solution.

The stability testing from the oven showed that the caring ingredients did not affect the stability of the formula after four weeks and 4° C. One could see that the base coat, to the left, was not affected by the addition of caring ingredients. The pigments in the samples with color have diverted in both the sample with and without caring ingredients; which indicates that the caring ingredients did not cause this. Instead the heat from the oven has this effect on the formula but shaking the bottle solves this fact. Figure 9 shows the results from the stability testing in heat.

Figure 9 - The nail polish samples after stability testing for four weeks in the oven. The base coat, placed in the middle has not been affected at all. The bottle to the left contains caring ingredients and the bottle to the left contains no caring ingredients. Since the color pigments have diverted in both of them it is not due to the caring ingredients.

The UV tests, which are illustrated in figure 10, showed that the pigments had separated from the formula after 30 hours both in the sample with and without caring ingredients. This means that the
Development of a nail polish with minerals as caring ingredients

2014-06-20

Caring ingredients did not cause this. Consequently the nail polish should not be placed in the sun for a long time.

Figure 10 - The tests after UV-setup. The sample to the left contains caring ingredients. Sample number two from the left contains no caring ingredients. In both sample one and two the color has diverted. The base coats, sample four and five from the left, have not been affected at all. Sample five contains caring ingredients.

11.1.2 NAIL POLISH REMOVER
The stability tests of the nail polish remover showed that the remover was stable through all the tests. Pictures of the results can be seen in figure 11.

Figure 11 – Pictures of samples of nail polish remover after stability testing. From left to right the samples presented are cold, room temperature, UV-light and heat.

11.2 HARDNESS TESTING
The tests using the AFM equipped with micro-indenter showed that the nail polish with the caring ingredients had a higher mean value of the hardness, 8210 MPa compared to the mean value of the reference, 8048 MPa. This indicates that the hardness is increased from the minerals and the almond oil. This is good since the nail polish has to be resistant towards damage and wear. Results from the hardness testing can be found in appendix 1. The tests of the other nail polish brands cannot be presented due to breakdown of the indenter.
11.3 MORPHOLOGY

The results from the initial run with SEM showed a difference of the top and the backside of the nail. Since the backside of the nail is the natural state which have not been destroyed from wear this is what is wanted after treatment with the nail polish. The pictures below show the difference in appearance for the backside and the surface of the nail. It can be seen that the backside, the left picture, is smoother than the surface.

![Figure 12 - The backside of the nail is the picture to the left and the picture to the left is the surface of the nail. The bottom of the nail has a smoother surface and the same look is wanted for the surface after treatment with the nail polish.](image)

After treatment with the nail polish pictures were taken and compared with the initial surface pictures to see the difference. Pictures with the same enlargement were compared.

In the following pictures the left ones represent the nail after four weeks and the right ones are initial pictures. As mentioned before, moisture is important to the nail and the almond oil has contributed with this. Also the minerals have filled out the cracks in the nail which has stopped the cracks for becoming larger. The following pictures show a smoother surface after treatment with the nail polish. It is clear that the cracks have been reduced since the distance between the keratin layers has been lowered. Once the minerals penetrate the cracks they cannot become wider.
Figure 13 – The nail surface is smoother after four weeks treatment with the nail polish. There are no cracks like in the left picture, before treatment with the nail polish.

Figure 13 - The nail surface is smoother after four weeks, the left picture then before treatment with the nail polish.
Figure 14 - The nail surface is smoother after four weeks treatment, the left picture then before treatment, right picture. The cracks in the keratin layers are wider before treatment.

The pictures from the before and after studies show that the surface of the nail is smoother after treatment with the nail polish. The gaps between the layers of keratin have been reduced. This is due to the choice of good ingredients in the nail polish and also the almond oil which has contributed with antioxidants which have protected the keratin from free radicals. Also, the minerals have filled out cracks in the nail, which prevent cracks that already exist from becoming larger.

11.4 NAIL POLISH REMOVER

Different combinations of the ingredients were tried out in order to achieve a perfect nail polish remover. The important factors were that the remover had to remove the nail polish completely in an easy way. The procedure could not take longer time than using a regular nail polish remover. One also wanted the remover to be gentle, not smell too much and for the oil to moisten the nail and protect it from becoming dry. Different combinations were tried out to meet all of these requirements and the most suitable formula was found.

Table 2 - The final composition of the nail polish remover

<table>
<thead>
<tr>
<th>Ingredient</th>
<th>Amount (ml)</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ethanol</td>
<td>32</td>
<td>46</td>
</tr>
<tr>
<td>Ethyl lactate</td>
<td>21</td>
<td>30</td>
</tr>
<tr>
<td>Castor oil</td>
<td>12</td>
<td>17</td>
</tr>
<tr>
<td>Water</td>
<td>5</td>
<td>7</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>70</strong></td>
<td><strong>100</strong></td>
</tr>
</tbody>
</table>

The picture below shows the results when the nail polish remover was used. All of the nail polish has been removed and the skin around the nail does not appear to have more dryness to it.
11.5 GROUP STUDY

The main results from the group study have been summed up below. The general verdict of the nail polish was good and one will keep the information from the focus group as reference throughout the rest of the development of this product.

Table 3 - The mean values of the results from the group study

<table>
<thead>
<tr>
<th>Quality</th>
<th>Score (1-5 were 5 is the best)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Drying time</td>
<td>4.5</td>
</tr>
<tr>
<td>Coverage</td>
<td>4.6</td>
</tr>
<tr>
<td>Smell</td>
<td>3.7</td>
</tr>
<tr>
<td>Consistency</td>
<td>4.0</td>
</tr>
<tr>
<td>Easy to apply</td>
<td>4.3</td>
</tr>
<tr>
<td>Easy to remove</td>
<td>4.0</td>
</tr>
<tr>
<td>Long-lasting</td>
<td>3.6</td>
</tr>
<tr>
<td>General opinion of the nail polish</td>
<td>4.3</td>
</tr>
</tbody>
</table>
The women were very positive to the nail polish in general and all of the participants would buy the nail polish if it would be available on the market today. Most of them would like a wider brush and a square bottle. One of the participants could consider paying 0-49 SEK for the nail polish, one would like to pay 89-109 SEK, six of them 70-89 SEK and four of them 109 SEK or more. A score in the group study below 4 is not considered good enough. The group study showed that the smell and the long-lasting quality were not approved by the participants. These qualities will therefore be investigated in the future and the improved formula will once again be tested in a group study.

11.6 MARKET ANALYSIS
When a new product is developed it is important that the product fulfills the void in the market. In order to find out what the customers want and which colors would be important to develop the employees of different pharmacies were interviewed.

The pharmacies in Sweden do not longer belong to a monopoly and due to this different pharmacies can carry the selection of products that they themselves want. The employees from the three largest pharmaceutical chains were interviewed. The answers and conclusions are summed up below and the original questions can be found in Appendix 3.

- Women of all ages buy nail polish at the pharmacies.
- If a pure and caring nail polish is developed it is important to carry trendy colors in the selection in order to avoid being considered as a boring brand.
- Base- and top coat are two very important products.
- The maximum price that one can charge for a pure and caring nail polish is 100 SEK.
- It is important that the nail polish dries fast, has good coverage and stays on for long time.
- Smaller bottles are a way of lowering the price.
- None of the questioned pharmacies sell a nail polish remover that markets a caring one.
- There is some request of a pure and caring nail polish, especially from customers that have fragile nails, allergies or fungus.
- No new products are planned to be launched anytime soon.
- The employees of pharmacies have a lack of knowledge about their selection of nail polish and the ingredients that they contain.
12. THE FINAL PRODUCT

12.1 DESIGN AND COLORS
The nail polish bottle will be made out of glass and contain 9 ml. The bottle will have a square shape and a square cap with silver lining and IDUN Minerals logo on it.

The colors have been carefully selected to fit the brand of IDUN Minerals. A top coat and a base coat will be featured in the line and also the 13 colors which can be seen in the pictures below. The line will also include one top coat and one base coat.

![Figure 16 - The nail polish colors that will be featured in the line of IDUN Minerals](image)

12.2 ECONOMIC ASPECTS
The economic aspects always have an important role in product development. Compared to other high quality make-up brand such as Tromborg or bareMinerals, IDUN Minerals is sold at a relatively low price. Thus, the nail polish developed needs to be of high quality but also have a reasonable manufacturing price.

A lot of time was spent on finding suitable caring ingredients, originating from natural sources, at good price. Adding the caring ingredients to the original formula from Fiabila could not affect the price of the product too much. The prices of almond oil and Dead Sea salt are considered good enough.

12.2.1 PRICING
It is not easy to put the right price on a product. As a start, the prices for some popular products of the mineral makeup brand Tromborg were compared to the prices of IDUN Minerals. This would give an indication of a reasonable price of the nail polish.

<table>
<thead>
<tr>
<th>Type of product</th>
<th>Tromborg</th>
<th>IDUN Minerals</th>
<th>% of Tromborg's price</th>
</tr>
</thead>
<tbody>
<tr>
<td>Foundation</td>
<td>475 SEK (8 g)</td>
<td>349 SEK (9 g)</td>
<td>66</td>
</tr>
<tr>
<td></td>
<td>59 SEK/g</td>
<td>39 SEK/g</td>
<td></td>
</tr>
</tbody>
</table>
Development of a nail polish with minerals as caring ingredients

2014-06-20
Caroline Thunstedt

<table>
<thead>
<tr>
<th>Mascara</th>
<th>255 SEK (5 ml)</th>
<th>199 SEK (14 ml)</th>
<th>27</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>51 SEK/ml</td>
<td>14 SEK/ml</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Eye pencil</th>
<th>175 SEK (1,13 g)</th>
<th>139 SEK (1,14 g)</th>
<th>79</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Lipstick</th>
<th>345 SEK (3,5 g)</th>
<th>189 SEK (4g)</th>
<th>47</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>99 SEK/g</td>
<td>47 SEK/g</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Eye shadow</th>
<th>220 SEK (3,4g)</th>
<th>129 SEK (3 g)</th>
<th>66</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>65 SEK/g</td>
<td>43 SEK/g</td>
<td></td>
</tr>
</tbody>
</table>

The percentages vary a lot and thus the mean value was calculated;

\[
\frac{66 + 27 + 79 + 47 + 66}{5} = 57\% 
\]

Hence, the price of the nail polish could be set to 57% of the price of the Tromborg nail polish price (180 SEK).

\[
180 \times 0.57 = 102.6 \text{ SEK}
\]

This gives a price of 10.2 SEK/ml. The nail polish from IDUN Minerals will most likely contain 9 ml and the price can be set to;

\[
9 \times 10.2 = 91.8 \text{ SEK}
\]

A suitable price for the nail polish, based on the calculations above is 89 SEK.

12.2.2 IDUN MINERALS PRICES

In figure 4, the price range of the currently available products from IDUN Minerals is shown below. The nail polish will be the cheapest product in the makeup line.
13. ETHICS

Due to the guidelines of IDUN Minerals, the ethics in this product development is an important factor. No animal testing has been used to develop this product. The nail polish remover developed will be an organic product, a fact that IDUN Minerals is very proud of. Also, the nail polish is 80% bio based and the caring ingredients originate from natural sources. The ethics and the importance of environmentally friendly choices has been an important factor throughout the whole project.

The nail polish formula in this project is a new way of thinking. Nail polish is a very popular cosmetic product. Thus, the need for more environmental friendly products is big. The product develop will hopefully inspire other nail polish brands to look at more environmental friendly solutions.

14. SAFTEY REPORT

For all products of IDUN Minerals there is a safety report made by a safety assessor. This is a very important document and a similar document has been made in this project. The documentation is needed if anyone would like to have information about the products of IDUN Minerals and the purity or toxicology of them. The safety report can be found in Appendix 4.
15. FUTURE WORK

This project will be extended in the form of employment of IDUN Minerals. The nail polish is a part of the product development and before the final product is done. There are lots of decisions left to be made but the final formula has been developed during this master thesis project.

The formula of the nail polish will be overlooked in order to make the nail polish more long lasting. It will be of importance that the adhesives and plasticizer are good enough. Otherwise these will be revised and exchanged. The final design of the nail polish bottle and the design of the packaging will also have to be decided on shortly.

16. CONCLUSION

The purpose of this master thesis project was to develop a nail polish for IDUN minerals. The final product matches the requirements of IDUN minerals regarding minimal amount of ingredients, purity and include caring ingredients. The final formula has been evaluated through a safety report and is considered good. The nail polish provides good coverage, dries fast and is also easy to remove according to the group study. The caring ingredients almond oil and Dead Sea Salt have resulted in a smoother surface of the nail which was shown in the SEM pictures. The hardness of the nail polish was tested using an AFM equipped with micro indenter. The hardness proved to be better for the nail polish with the caring ingredients. The nail polish and the nail polish remover passed the stability tests made and can therefore start being manufactured in the factory of Fiabila. A nail gentle polish remover was also developed and will be included in the launch of the nail polish in February 2015. The line will contain 15 colors and the price will be 89 SEK for a bottle that contains 9 ml.

Also, the nail polish is bio based to 80 % and can be considered an environmental friendly good choice which hopefully will inspire other nail polish brands to choose bio based ingredients as well.
Development of a nail polish with minerals as caring ingredients

2014-06-20

Caroline Thunstedt

17. REFERENCES


2 Nordic AB. Product guide. Nordic AB. 2013

3 Forsberg, Hanna. Product developer and manager of education, Nordic AB, Education and interview. 2014-01-21

4 Broschy. Nordic AB. 2013

5 Broschy. Nordic AB. 2013

6 Wilhelmsson, Alexia. Marknadsplan. 2012


Development of a nail polish with minerals as caring ingredients

2014-06-20

Caroline Thunstedt


24 Lodén, Marie. IDUN minerals ingredienser. 2013


APPENDIX 1 – HARDNESS TESTING

Values from three tests using indentation.

<table>
<thead>
<tr>
<th>Reference</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
</tr>
</thead>
<tbody>
<tr>
<td>Indentation</td>
<td>Indentation</td>
<td>Indentation</td>
<td>Indentation</td>
<td>Indentation</td>
<td>Indentation</td>
</tr>
<tr>
<td>Acquisession: 10.0 [Hz]</td>
<td>Acquisession: 10.0 [Hz]</td>
<td>Acquisession: 10.0 [Hz]</td>
<td>Acquisession: 10.0 [Hz]</td>
<td>Acquisession: 10.0 [Hz]</td>
<td>Acquisession: 10.0 [Hz]</td>
</tr>
<tr>
<td>Linear Loading</td>
<td>Linear Loading</td>
<td>Linear Loading</td>
<td>Linear Loading</td>
<td>Linear Loading</td>
<td>Linear Loading</td>
</tr>
<tr>
<td>Loading Rate</td>
<td>Loading Rate</td>
<td>Loading Rate</td>
<td>Loading Rate</td>
<td>Loading Rate</td>
<td>Loading Rate</td>
</tr>
<tr>
<td>Unloading Rate</td>
<td>Unloading Rate</td>
<td>Unloading Rate</td>
<td>Unloading Rate</td>
<td>Unloading Rate</td>
<td>Unloading Rate</td>
</tr>
<tr>
<td>Max Load</td>
<td>Max Load</td>
<td>Max Load</td>
<td>Max Load</td>
<td>Max Load</td>
<td>Max Load</td>
</tr>
<tr>
<td>Load in standard range</td>
<td>Load in standard range</td>
<td>Load in standard range</td>
<td>Load in standard range</td>
<td>Load in standard range</td>
<td>Load in standard range</td>
</tr>
<tr>
<td>Unloading in standard range</td>
<td>Unloading in standard range</td>
<td>Unloading in standard range</td>
<td>Unloading in standard range</td>
<td>Unloading in standard range</td>
<td>Unloading in standard range</td>
</tr>
<tr>
<td>Pause</td>
<td>Pause</td>
<td>Pause</td>
<td>Pause</td>
<td>Pause</td>
<td>Pause</td>
</tr>
<tr>
<td>Analysis n°1</td>
<td>Analysis n°1</td>
<td>Analysis n°1</td>
<td>Analysis n°1</td>
<td>Analysis n°1</td>
<td>Analysis n°1</td>
</tr>
<tr>
<td>+ Additional results</td>
<td>+ Additional results</td>
<td>+ Additional results</td>
<td>+ Additional results</td>
<td>+ Additional results</td>
<td>+ Additional results</td>
</tr>
<tr>
<td>Hypothesis</td>
<td>Hypothesis</td>
<td>Hypothesis</td>
<td>Hypothesis</td>
<td>Hypothesis</td>
<td>Hypothesis</td>
</tr>
<tr>
<td>Poisson’s ratio</td>
<td>0,3</td>
<td>0,3</td>
<td>0,3</td>
<td>0,3</td>
<td>0,3</td>
</tr>
<tr>
<td>+ Additional results</td>
<td>+ Additional results</td>
<td>+ Additional results</td>
<td>+ Additional results</td>
<td>+ Additional results</td>
<td>+ Additional results</td>
</tr>
<tr>
<td>Fmax</td>
<td>757,4 mN</td>
<td>Fmax</td>
<td>758,84 mN</td>
<td>Fmax</td>
<td>758,84 mN</td>
</tr>
<tr>
<td>S</td>
<td>1,4235 mN/nm</td>
<td>S</td>
<td>1,4235 mN/nm</td>
<td>S</td>
<td>1,4235 mN/nm</td>
</tr>
<tr>
<td>Eit</td>
<td>1919,85 mN</td>
<td>Eit</td>
<td>1919,85 mN</td>
<td>Eit</td>
<td>1919,85 mN</td>
</tr>
<tr>
<td>0,74</td>
<td>0,74</td>
<td>0,74</td>
<td>0,74</td>
<td>0,74</td>
<td>0,74</td>
</tr>
<tr>
<td>1862,51 mN²</td>
<td>1862,51 mN²</td>
<td>1862,51 mN²</td>
<td>1862,51 mN²</td>
<td>1862,51 mN²</td>
<td>1862,51 mN²</td>
</tr>
</tbody>
</table>

Caroline Thunstedt

Development of a nail polish with minerals as caring ingredients

2014-06-20
**APPENDIX 2 – QUESTIONS GROUP STUDY**

<table>
<thead>
<tr>
<th>Nail polish</th>
<th>Fokusgrupp 2014</th>
<th>KOMMENTERA GÄRNA SÅ MYCKET SOM MöJLIGT, TACK :)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ålder/age:</td>
<td>PLEASE COMMENT:)</td>
<td></td>
</tr>
<tr>
<td>Kön/Sex:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Vad brukar du köpa för märke när du köper nagellack? (Which brands do you normally buy?)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Vilka färger använder du? (om flera rangordna efter den du använder mest) (Which colors do you use the most?)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Vad brukar du betala för ett nagellack? (How much do you normally spend on a nail polish?)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hur många lager av ditt nagellack applicerar du vanligtvis? (How many layers do you apply?)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rangordna 1-5 där 5 är det bästa (Please rank)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Vad tycker du om torktiden? (drying time)</td>
<td>1-Inte bra 2-OK 3-Bra 4-Mkt bra 5-WOW!</td>
<td></td>
</tr>
<tr>
<td>Kommentar</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Vad tycker du om täckningen? [OBS endast 1 lager] (coverage)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Kommentar</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Vad tycker du om doften? (smell)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Kommentar</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hur är konsistensten? (consistency)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Kommentar</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hur är applicerbarheten? (easy to apply)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Kommentar</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hur lätt var nagellacket att få bort? (easy to remove)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Kommentar</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hur var hållbarheten för nagellacket? (long-lasting)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Kommentar</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Vad tycker du om nagellacken överlag? (general opinion)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Kommentar</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Vad skulle du kunna tänka dig att betala för detta nagellack? (pay)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Kommentar</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>0-49</th>
<th>70-89</th>
<th>89-109</th>
<th>109+</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vad är viktigast för dig när du köper nagellack? (most important factor)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pris</td>
<td>Färg</td>
<td>Ingredienser</td>
<td>Hållbarhet</td>
</tr>
<tr>
<td>Förpackning</td>
<td>Borste</td>
<td>Miljövänlighet</td>
<td>Flaskans design</td>
</tr>
<tr>
<td>Övrigt</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**FRÅGOR**

Är det något som skiljer de två nagellacken åt? I så fall, vad? (any difference?)

Är det något du tyckte var särskilt bra med nagellacken? I så fall vad? (Extra good?)

Är det något du tyckte var mindre bra med nagellacken? I så fall vad? (Bad?)

Vad skulle du vilja ha för borste till nagellacket? (small, bred, lång, kort) (What kind of brush?)

Skulle du köpa detta nagellack om det fanns på marknaden idag? MOTIVERA! (Would you buy it?)

**APPENDIX 3 – QUESTIONS MARKET ANALYSIS**
1. Which nail polishes do you carry in your selection? Why these kinds? What is unique with these?

2. Does the customer ask for anything in particular?

3. Is it women of a certain age that buys nail polish?

4. Is there any request of a pure and caring nail polish?

5. Do you carry a nail polish remover in your selection? What is special with this one? Quality, price, caring ingredients?

6. Which colors are more popular?

7. Do you know if you have any new products that are supposed to be launched soon?

8. What do you think that the typical customer would pay for a pure and caring nail polish?

9. Is there anything that you lack in your selection?

APPENDIX 4 – SAFTEY REPORT
Development of a nail polish with minerals as caring ingredients

2014-06-20
Caroline Thunstedt

Nail polish
Safety report

2014-05-21
The Royal Institute of Technology
Caroline Thunstedt

Table of Contents
Summary ..................................................................................................................... 2
Cosmetic product safety information .................................................................................. 2
Composition IDUN nail polish .......................................................................................... 2
Physical/chemical characteristics and stability of the cosmetic product ................................ 2
Microbiological quality ....................................................................................................... 2
Impurities, traces, information about the packaging material .............................................. 3
Normal and reasonably foreseeable use ............................................................................. 3
Exposure to the substances ................................................................................................ 3
Summary
In this safety document one would like to present the potential risks of the nail polish from IDUN minerals. The nail polish was developed as a master thesis work from a student of the Royal Institute of Technology using an original formula from a French nail polish manufacturer. The requirements of the nail polish are to have high quality, good coverage and also have caring qualities.

Cosmetic product safety information
A new type of cosmetic product in the **IDUN** range has been developed; a series of nail polish with caring ingredients. The product is compliant with the EU Cosmetics Regulation.

**Composition**

- ETHYL ACETATE
- BUTYL ACETATE
- NITROCELLULOSE
- ADIPIC ACID/NEOPENTYL GLYCOL/TRIMELLITIC ANHYDRIDE COPOLYMER
- ISOSORBIDE DICAPRYLATE/CAPRATE
- ALCOHOL
- N-BUTYL ALCOHOL
- ETOCRYLENE
- WATER
- CAPRYLIC/CAPRIC TRIGLYCERIDE
- PISTACIA LENTISCUS (MASTIC) GUM OIL
- TRIMETHYLPENTANEDIYL DIBENZOATE
- ISOMALT
- VIOLET 2
- LACTIC ACID
- PHOSPHOLIPIDS
- RHODODENDRON FERRUGINEUM LEAF CELL CULTURE EXTRACT
- SODIUM BENZOATE
- PRUNUS AMYGDALUS DULCIS (SWEET ALMOND) OIL
- MARISAL

**Physical/chemical characteristics and stability of the cosmetic product**

The product is a mixture of solvents, film forming agent, plasticizers, color pigments, adhesives and caring almond oil along with Dead Sea salt. The formulation is solvent based. Thus, the need for preservatives is unnecessary. The stability is investigated using standard techniques for the certain product and the data shows that the composition will have the stability like any other nail polish.

**Microbiological quality**

Challenge testing is mandatory for all those products which, in normal conditions of storage and use, a risk of infection for the consumer or a deterioration of the product exist. The formula is solvent based along with the sealed packaging prevents contamination.

**Impurities, traces, information about the packaging material**

The presence of potential impurities and traces in the raw material is available in the raw material specifications, detailed in the product information file.

**Normal and reasonably foreseeable use**

IDUN nail polish is a liquid formula filled in a bottle made of glass. The name of the product and the intended use are clearly stated on the product. The normal usage of the product is on the nails of hands and toes. Secondary exposure to the product (e.g. inhalation or ingestion) is not likely. Children are not the target group and will most likely not use this product without the watch of a
grown up. The look of the product is not intended to mimic food or beverage. Thus, the risk of the product to be ingested is much reduced.

**Exposure to the substances**
Nail penetration of solvent, pigments and particles is not likely. Consequently, exposure of the substances in the intended way is of no toxic concern. However, big proportions of inhalation or intake of the nail polish is harmful.

**Ingredients**

**Butyl acetate** 123-86-4
A solvent used in most nail polish but also in other types of lacquers. It is used to dissolve the nitrocellulose. It consists of six carbons, two oxygen and twelve hydrogens and can for example be found in many types of fruit. It can be used as a synthetic fruit flavoring in foods such as candy and ice cream. It is a colorless liquid which is flammable. Butyl acetate can cause dryness to skin and dizziness if inhaled. When in contact with eyes, rinse thoroughly.

**Ethyl acetate** 141-78-6
Ethyl acetate is a solvent often used in cosmetics and in nail polish due to the good solvation of nitro cellulose. It is most often manufactured by Fischer esterification reaction of ethanol and acetic acid. It is a colorless liquid with a sweet smell which is used in glues, nail polish remover and in cigarettes. Its main hazards are irritant and flammable and should be handled carefully.

**Nitrocellulose** 9004-70-0
Nitrocellulose is the film former which is used in most nail polishes as a film former. However, it is also used in explosives. The nitro cellulose can easily explode in its dry state but it is harder to achieve explosion when it is wet. Thus, nitrocellulose in nail polish is considered safe. Nitrocellulose is manufactured by mixed sulphuric and nitric acid to it. Before usage the acids are neatly rinsed away using water. The manufacturing process differs from regular cellulose and thus also the chemical reaction.

**Adipic acid/neopentyl glycol/trimellitic anhydride copolymer** 28407-73-0
This substance is used as a film-forming agent in the nail polish.

**Isosorbide dicaprylate/caprate** 1215036-04-6
Isosorbide dicaprylate/caprate is a plasticizer, a diester of isosorbide and a mixture of caprylic and capric acids.

**Alcohol** 64-17-5
Ethanol is commonly known as alcohol and is the least toxic one towards humans.

**n-butyl alcohol** 71-36-3
Is also called n-butanol and is an alcohol used as a solvent or for perfuming a product. It is often used in food and beverages and is therefore considered as suitable solvent for cosmetics.

**Etocrylene** 5232-99-5
Is the UV absorber in the nail polish. This is used in order to make sure that the nail polish formula stays stable and that the pigments does not devide from the formula.

**Water** 7732-18-5  
This nail polish formula contains water and is used as a solvent. It raises no health concerns.

**Caprylic/Capric Triglyceride** 73398-61-5 / 65381-09-1  
This component can be used for masking and perfuming and is also skin conditioning.

**Pistacia Lentiscus (Mastic) Gum Oil** 61789-92-2  
Is an oil used since it can function as antimicrobial and perfuming.

**Trimethylpentanediyl Dibenzoate** 68052-23-3  
Is used as a plasticizer in the nail polish.

**Isomalt** 64519-82-0  
A complex mixture of polysaccharides obtained by enzyme treatment of sucrose. Is used as a humectant

**Violet 2** 3248-91-7  
Is a color ingredient that for example can be used in hair dying.

**Lactic Acid** 50-21-5  
This acid can be used in order to receive buffering, skin conditioning and humectant.

**Phospholipids** 123465-35-0  
Lipids are used in the nail polish because they are skin conditioning.

**Rhododendron Ferrugineum Leaf Cell Culture Extract** 90106-21-1  
Rhododendron Ferrugineum Leaf Cell Culture Extract is used as skin conditioning and has its originate in the culture of the leaf cells of Rhododendron ferrugineum

**Sodium Benzoate** 532-32-1  
Is used as a masking ingredient in the nail polish. Can also be used as a preservative.

**Prunus Amygdalus Dulcis (Sweet Almond) Oil**  
Almond oil is often used in nail treatments since it gives moisture and provides the nail with the antioxidant vitamin E

**Marisal**  
Dead Sea Salt can be used in skincare due to its high mineral content.

**Undesirable effects and serious undesirable effects**  
In open literature one cannot find any literature suggesting that similar products could cause undesirable effects. All types of complaints will be collected by Letsfaceit and be further investigated. Letsfaceit will address any health-related complaints in accordance with international standard operating procedures conforming to the cosmetic regulation.
Information on the cosmetic product
No animal tests have been performed during the development of the nail polish. Informal tests in the lab on humans have however been done during the development. These have been executed carefully and did not suggest any safety issues.

Cosmetic product safety assessment
Assessment conclusion
The cosmetic product in the present report is considered to be safe for human health when used under normal or reasonably foreseeable conditions of use, taking into account the presentation, labelling and instructions for use.

Labelled warnings and instructions of use
Since the nail polish contains flammable solvents a warning symbol will be added to the package. No certain instructions of use will be added.

References
European Comission Health and Consumers

Reasoning
The nail polish developed in this mater thesis project is considered a safe product when used according to its purpose.