UV GEL EXPLAINED

ESSENTIAL KNOWLEDGE FOR THE BEAUTY INDUSTRY

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Introduction

In this eBook, we will examine UV Gel nail systems and the process that transforms a semi-solid liquid product on the nail into a durable, hard nail coating. You will discover how the seemingly simple action of applying a gel to a nail and exposing it to UV light involves complex scientific principles. Together, we will unravel these mysteries, offering a deeper appreciation for the innovation and expertise behind every UV gel nail.

This eBook is designed to be an essential guide for professionals and enthusiasts alike, delving into the process of how these popular nail products work and the science that drives their effectiveness, as well as the importance of a 'proper cure'. We believe all nail enthusiasts and professionals need to understand UV gel nail systems, for safe and effective application. Understanding the principles contained in this book not only enhances the quality of nail services but also ensures client safety, making it an indispensable resource for anyone serious about mastering the art and science of nail care.

At the heart of this nail product is the fascinating chemical process of polymerisation - the reaction that turns UV Gel into a solid nail coating. We will explain this process, understanding how UV light plays a crucial role. We will examine the importance of acrylic compounds in the nail industry, their diverse forms, and the critical need for safety in their use. We will explore how this family of chemicals, though beneficial, comes with potential risks.

We will help you understand the polymerisation process, breaking down how it occurs in nail products and its implications for safety and efficiency. You will gain insights into the journey of monomers and oligomers, as they go from a liquid to solid, joined polymer chains - a transformation necessary for UV Gel nail products to harden.

The rate of polymerisation is a delicate balance. We will discuss how the speed of this chemical reaction can impact the final product, touching on the hazards of both rapid and slow polymerisation, and the importance of achieving a 'proper cure' for durability and safety.

We will highlight the importance of adhering to specific nail coating systems. These systems, crafted by chemists, are designed to ensure the safe and effective curing of nail coatings, emphasising the need for following manufacturer instructions closely.

We will look into UV lamps and their use and safety, and common misconceptions. Scientific studies, including a comprehensive 2013 analysis of UV lamps, have confirmed the safety of both LED-style and traditional Fluorescent-style UV nail lamps when used according to manufacturers' guidelines. This research, adhering to international standards, provides reassurance about the safety and efficacy of these lamps in the professional nail care industry. As we will examine, it is in their use and care, that safety risks and an incomplete cure can occur.

This comprehensive guide aims to provide you with a thorough understanding of the science and art behind UV Gel nail systems, equipping you with the knowledge to excel in your practice or simply satisfy your curiosity about this fascinating aspect of nail technology.

Whether you are an experienced nail technician or simply a nail art enthusiast, this eBook promises to enrich your understanding and enhance your skills in the world of professional nail care.

Early Developments in Nail Polish

The origin of nail polish can be traced back thousands of years to ancient civilisations where it was used as a status symbol. Initially, nail colourings were derived from natural sources like henna. Nail polish, as we know it, began evolving in the early 20th century with the use of nitrocellulose, a chemical compound, to create a glossy sheen. This marked a significant shift from traditional recipes, laying the foundation for contemporary nail systems.

Emergence of Gel-Based Formulations

The introduction of gel-based formulations was an important moment in nail care history. In the late 20th century, some companies began experimenting with acrylic molecules that hardened under UV light. This led to the development of the first gel nail systems, offering a sturdier and longer-lasting alternative to traditional lacquers and polishes. These early gel systems were a breakthrough, providing a more durable and resilient nail coating.

UV gel polishes appeared to be an innovative solution to common problems associated with traditional nail polishes, such as long drying times and short-lasting finishes. The first commercial brands of UV gel polishes emerged in the early 2000s, offering a revolutionary approach to nail colouring.

Technological Advancements in Gel Polish

Technological advancements have played a crucial role in refining gel polish formulations and application processes. The introduction of LED/UV curing lamps reduced curing times and energy consumption. Innovations in polymer chemistry led to more flexible, stronger, and diverse colour ranges in gel polishes.

Evolution of UV Gel Polishes

These advancements not only improved the quality and durability of gel polishes but also improved user safety and environmental sustainability.

As technology evolved, UV gel polishes became more sophisticated. The formulation of the gels improved, with advancements leading to a wider range of colours, enhanced durability, and easier application processes.

The Rise in Popularity

The popularity of UV gel polishes soared due to their long-lasting nature and high-gloss finish. Salons and consumers embraced these products, which offered a durable solution, resistant to chipping and peeling - common issues with traditional polishes. This led to a boom in creative nail art, with UV gels providing a stable canvas for intricate designs.

Safety and Health Innovations

With the rise in popularity, unfortunately the health and safety risks became increasingly clear with an increase in allergic reactions. Manufacturers refined the formulations to try and minimise potential allergens and reduce exposure to potentially harmful chemicals. Simultaneously, the industry created and promoted more education about the proper application techniques to ensure nail health and reduce cases of allergic reaction.

The Future of UV Gel Polishes

Today, UV gel polishes continue to evolve, with ongoing research focusing on eco-friendly options and further reducing the risk of skin allergies. The future of these polishes is set to bring more innovative changes, driven by technology and a growing commitment to safety and sustainability in the beauty industry.

Benefits of UV Gels

UV Gel Polishes have revolutionised the world of nail care with their distinct advantages over traditional nail polishes, offering long-lasting wear, striking visual appeal, and convenience. These benefits make UV gel polishes a preferred choice for both nail professionals and enthusiasts seeking quality and durability.

Longevity Compared to Traditional Nail Polish

One of the most significant benefits of UV gel polishes is their longevity. Unlike traditional polishes that often chip or peel within a few days, UV gel polishes can last up to two or three weeks without significant wear. This durability is a result of the chemical bond formed between the gel polish and the nail under UV light, providing a longer-lasting manicure.

Glossy Finish and Colour Vibrancy

UV gel polishes are known for their glossy finish and vibrant colours. The formulation of these polishes, combined with the curing process, creates a lustrous sheen that is difficult to achieve with regular nail polishes. Additionally, the colour pigments in gel polishes are vibrant and resistant to fading, maintaining their brightness for the duration of the wear.

Reduced Drying Time

Traditional nail polishes can take a while to dry completely, but UV gel polishes have a significantly reduced drying time. The curing process under a LED/UV lamp takes only a few minutes, hardening the gel polish. This quick hardening feature not only saves time but also reduces the risk of smudges or dents in the polish, leading to a more polished and professional finish.

Note: All LED nail lamps emit UV and there are no exceptions.

While our main focus is on UV gels, it is important to understand the wider family of chemicals called acrylics, which UV gels belong to.

Acrylics form the foundation of many nail products, including UV cured coatings. Understanding acrylics and their chemical properties helps in appreciating the care needed when applying and using acrylic based nail products, and the potential risks they pose.

By exploring the types of acrylics used in nail care, particularly those in UV gels, we gain insight into their widespread use, properties, and potential for allergic reactions.

This understanding is essential for professionals and nail enthusiasts aiming to provide safe, high-quality nail services.

Acrylics and their use

Acrylic is the name of a large group of chemicals used to create polymers (plastic materials) for a wide range of industries with many uses within dentistry, medicine, healthcare as well as manufacturing.

From dentures to joint replacements to automotive parts and furniture, acrylics can be found in every household and every aspect of our lives.

There are many types of acrylics, and several are used in nail products. From nail polishes to artificial overlays to nail adhesives to nail tips. You will find acrylics in lots of nail products. Acrylics are used because they offer versatility and durability. The chemistry behind these products dictates their behaviour on nails, from application to removal.

It is the properties of this family of chemicals that make it so useful.

Acrylics and UV Gels

All artificial nails are based on acrylic ingredients and cured according to the rules of acrylic chemistry.

While only acrylics that are deemed safe for cosmetic use are found in nail products; there are many potential skin allergens in the acrylics family, meaning individuals can develop an allergic skin reaction to certain ingredients with prolonged and/or repeated exposure.

No artificial nail coating product is meant to come into direct contact with the skin and this should always be avoided.

The acrylics are split into a number of different types. UV cured nail coatings typically use acrylates or methacrylates, two groups of chemicals within the acrylic family.

It is the ability of acrylics to polymerise has led to their extensive use within the industry, turning from a liquid into a solid material.

This polymerisation process is where individual molecules link together to form a larger, more complex tangle of long chains. This is a key property that makes acrylics ideal for creating durable, long-lasting nail products.

When acrylics polymerise, they transform from a liquid or soft state into a hard, resistant form, which is essential for the longevity and strength of nail enhancements and acrylic products, including UV gel coatings.

This unique property is fundamental to the functionality and popularity of acrylic-based products in nail care.

Polymerisation

Within UV Gels, are acrylic molecules called 'monomers' and short chains of these monomers called 'oligomers'. Polymerisation is when these molecules join together to create much longer chains, called 'polymers'. Understanding this process reveals the science behind nail products including UV gels.

The words 'monomer' and 'oligomer' describe the size and length of the molecules used in these products. Monomers are single units, while oligomers are short chains of these units '(mono' in monomer means one, 'oligo' in oligomer means 'few'). 'Poly' in polymer means many.

A UV Gel in its liquid form consists of millions of these short molecules of monomers and oligomers, all floating around, moving past each other. Oligomers are bulkier and while they cannot move as freely as single monomers, they still have the ability to move. Oligomers can become easily tangled as they move past each other, which is why UV Gels have a gel-like texture that appears thicker than mainly monomer containing products such as the liquid and powder system (L&P).

'Gel' is just a description of the product's consistency when stirred, and the gel-like appearance of UV Gels is due to the number of oligomers in the nail product.

The polymerisation process, as we will cover over the next few pages, is fascinating, and is how and why this free-flowing liquid of monomers and oligomers, forms a solid, hard polymer nail coating.

You might wonder why UV Gels are a mix of monomers and oligomers. Well, polymerising a liquid full of monomers with UV light is not very efficient. If UV Gels were made entirely of monomers, the gel would polymerise too slowly.

One way chemists found to improve efficiency was to already join some of the monomers into short chains called oligomers. Oligomers make it easier to create polymers. Joining a few hundred oligomers together is much faster and easier than joining a million individual monomers.

To visualise the polymerisation process, imagine a room full of individual people dancing -- one by one they join arms with the person next to them – until the most of them are connected. Once connected to a long chain of people, they would not be able to move at all.

That is the same as polymerisation. Lots of small, individual units moving around, dancing, becoming long, connected chains, that cannot move at all. From fluid and moving - to solid and static.

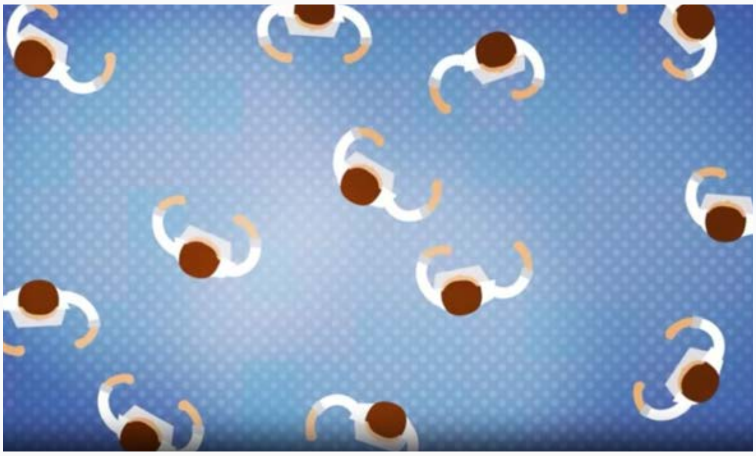

Figure 1: Imagine single monomers as independent dancers, each moving freely on their own, moving past each other and not joining together - a fluid, liquid mass.

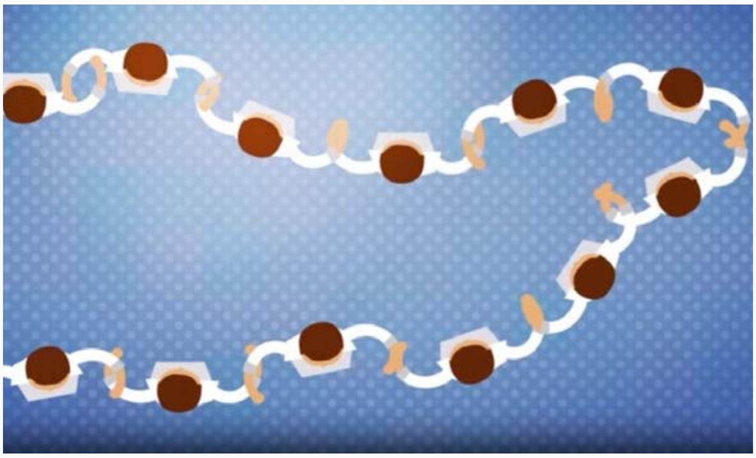

Figure 2: Once the chain reaction starts, they gradually link arms, transforming into a long interconnected chain - a solid polymer.

Polymerisation

Polymerisation is a chemical reaction, but the conditions need to be right for this reaction to happen and continue. For monomers or oligomers to cure and become a solid polymer, several things need to occur.

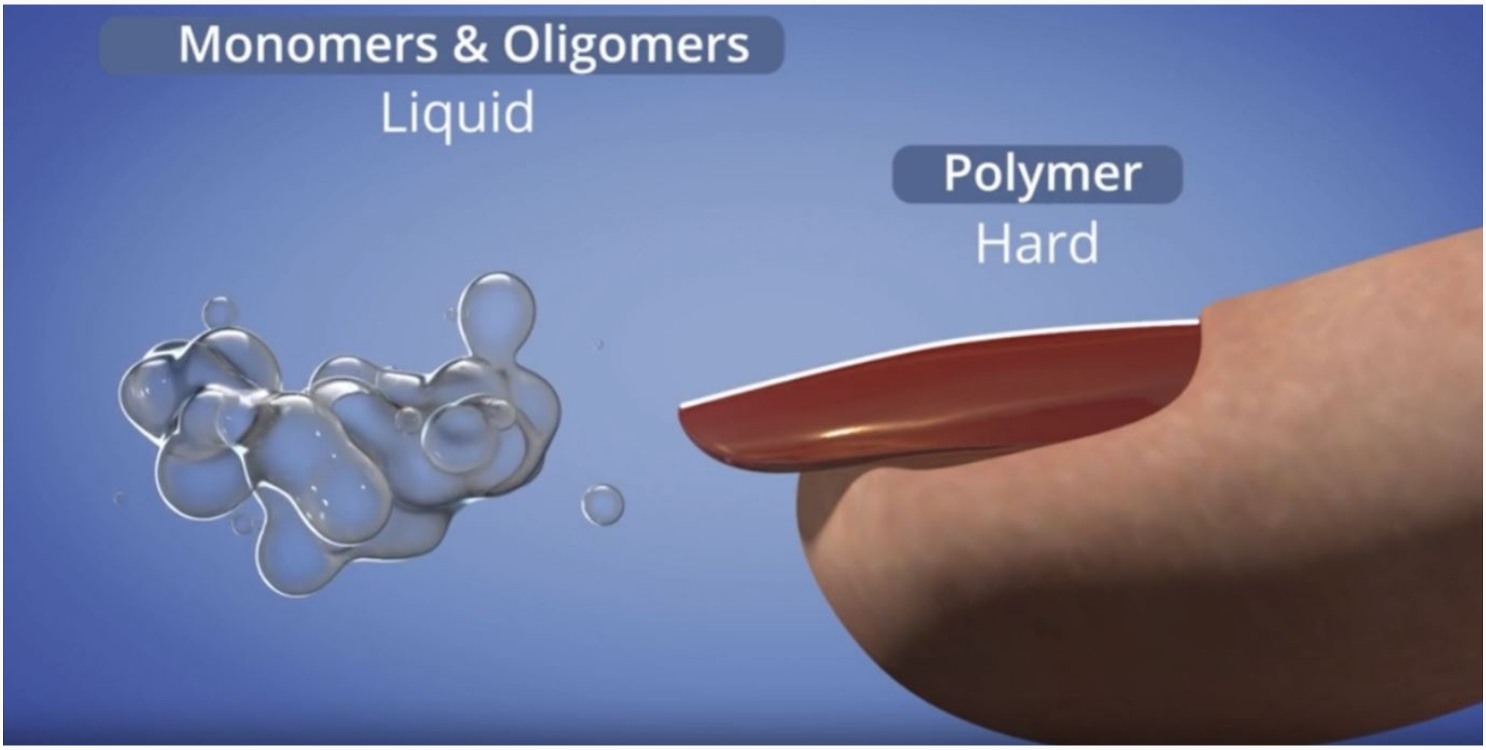

Figure 3: The gel-like, fluid mixture containing monomers and oligomers becomes a polymer when exposed to UV light.

An "initiator" is essential to kickstart the polymerisation reaction and facilitate the joining of monomers and oligomers into long chains. Typically, this is a chemical "trigger" present in the UV Gel. When exposed to energy, the initiator splits in half, with each half bonding to a monomer or oligomer, initiating the polymerisation process. In the context of a room of dancers, the initiator acts like the music that prompts everyone to start holding hands with each other. Without initiators, the polymerisation process wouldn't commence, much like dancers wouldn't dance without music.

Photoinitiators trigger the linking of molecules within the liquid, setting off a process where these molecules gradually interweave. As they intertwine, the molecules solidify, forming a strong, three-dimensional, net-like structure. Without a photoinitiator, this reaction wouldn't begin.

Photoinitiators are mixed into the gel and remain dormant until they receive the right energy, such as UV or LED light. This energy activates the photoinitiators and starts the polymerisation process. Polymerisation is fundamentally a chemical process powered by energy, and this energy is what activates the photoinitiator to initiate the reaction.

The initiators used by the UV curing system are special types that are sensitive to specific types of UV light. These are called photo initiators. The 'photo' part means UV light, this is the energy needed to start the polymerisation process. UV light is required to switch the initiators on and begin the process. The intensity of the UV light helps determine how quickly and how completely the polymerisation process will happen.

Figure 4: **Initiators, when exposed to UV light, split into free radicals. This starts the polymerisation process, and the chain reaction that links monomers and oligomers into polymers.**

In UV Gels, initiators are activated by the specific wavelengths of UV light emitted by a UV lamp.

Some UV gels contain complex blends of multiple initiators to help ensure more complete polymerisation, while some only contain one.

Initiators work much more efficiently when blended with a “catalyst”. Catalysts are used to control the rate of chemical reactions.

Going back to our room of dancing molecules, the catalyst determines the speed at which the music is playing. Without a catalyst the music is slow, and the dancers join together slowly. With a catalyst the music is played faster, so the dancers join together quickly. A catalyst does not join the growing polymer chains, these only control the speed of the reaction.

In nail coating products, catalysts help the photo initiator dramatically increase polymerisation so that a client’s nails can be filed and shaped within a few minutes, rather than a few hours.

Molecules are incredibly small, and inside a bottle of UV Gel, there are hundreds of trillions of acrylic molecules (both monomers and oligomers), along with initiators awaiting activation by UV energy, and catalysts that accelerate the reaction.

As it is easy to keep UV light away from UV Gels, the initiators, catalysts and monomers/oligomers can be combined into a single product and a single bottle rather than the two-part systems like L&P. This is one of the key advantages of UV gels, they can be premixed and ready to use.

We do not want polymerisation to happen too quickly. Each time two monomers and/or oligomers join, they release a tiny amount of heat. This is called an “exothermic” or heat-releasing reaction. The heat from two molecules linking together is too tiny to feel, but when billions of molecules are joining each second, this can release enough heat for the wearer to feel enough heat to cause pain.

It is normal for Some warmth to occur during the process -- but sometimes, especially if a mistake has occurred, this heat can become so intense that it damages the nail’s living tissue, burning the nail bed, and possibly causes the nail plate to lift from its nail bed, which can lead to infections under the nail plate. Besides a lot of pain, the worst-case scenario would be the complete or partial loss of the nail plate, infection of the nail unit, and possible long-term damage.

A scenario everyone wants to avoid.

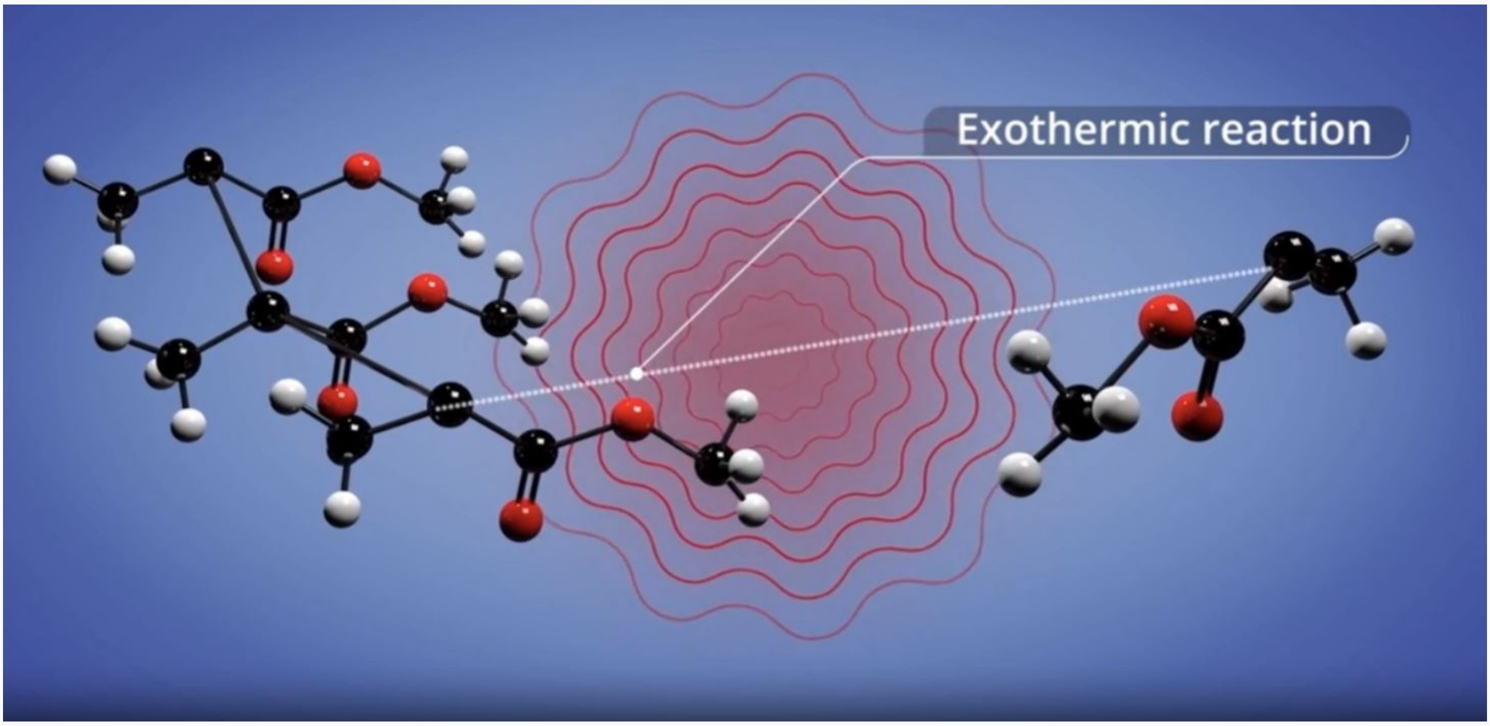

Figure 5: The polymerisation reaction between monomers and oligomers creates heat. This should not be enough to feel but occasionally it can be, and it can even burn the nail bed, in a worst case scenario.

It is also important to understand these reactions can also happen too slowly and result in under-curing. To go back to our analogy of a room of dancing individuals, if it takes most people 3 minutes to find someone to join arms with, and we stop everyone moving within 1 minute. Lots more people than we are expecting are going to be left unconnected, the chains are not going to be as long or as tangled. In a room full of dancers, that does not matter, unfortunately we are dealing with chemicals, and the ones that are left unconnected can produce problems. Many types of unreacted acrylic molecules found within UV Gel coatings are potential allergens.

Unreacted monomers are a cause of allergic reactions, especially during removal when those trapped monomer allergens are released and end up on the skin or as dust when filed or during a soak-off removal.
These unreacted ingredients are skin allergens and can over time result in an adverse reaction on the skin, called allergic contact dermatitis.
Under-cured acrylics will also be weaker and poorer quality.

Figure 6: **Avoid prolonged or repeated contact with oligomers and monomers as these are known allergens.**

Nail coatings will sometimes break because they are weak and overly flexible, so they do not last.

So, we do not want a process that is too fast – which risks damaging the nail bed with excessive heat - or one that is too slow – that increases the risk of an allergic skin reaction. With every nail coating, we are aiming for a 'proper cure'.

What is a proper cure? This is said to be achieved when at least 80% (or more) of the monomers and oligomers are joined in the longer polymer chains.

This is the same as saying approximately 80% polymerised, which is more than enough to ensure the unreacted ingredients are unlikely to cause allergic reactions and the nail coating will achieve its intended strength. It's worth noting that some experts suggest this value should be 90% or higher. However, most agree that when polymerisation is less than 80%, the likelihood of adverse reactions occurring over time increases.

Imaging our room of dancers again, if 80% of the people in the room are joining hands, the remaining 20% would find it difficult to move and would be trapped within the tangled mass of dancers. If only 60% of the people are holding hands, it's easier for those people to move and cause a problem.

A proper cure will ensure that the nail coatings properly adhere to a nail plate and are strong enough to withstand everyday/reasonable wear and tear.

Only a properly cured nail coating will have the intended strength and durability.

To avoid the dangers of under-cured products or reactions that generate too much heat – we have “nail coating systems”.

“Systems” is a term used often in nail products, and it is where a chemist formulates a set of products that are designed to be used together and cured in a specific way. These instructions and processes result in superior artificial nail coatings - long-lasting, durable, and safe for the natural nail and client – and if followed will result in a proper cure.

An individual carefully following a nail coating system, and the manufacturer’s instructions -- using the right products in the right sequence at the right time - is the best way to ensure the polymers properly form and create a safe nail covering.

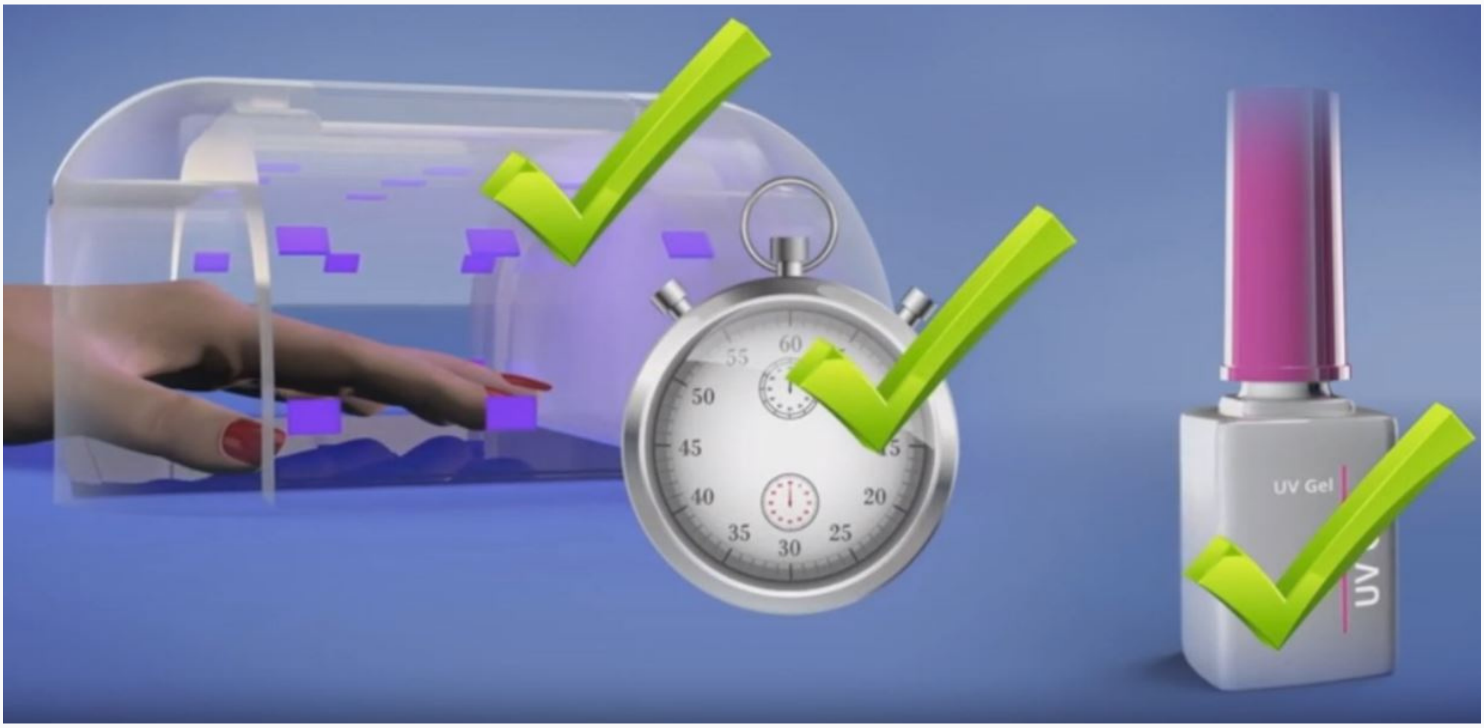

Figure 7: By following the chemist-designed System, you will use the correct UV wavelengths for right length of time which will ensure a safe, durable, long-lasting artificial nail coating.

UV Light

UV light, or ultraviolet light, is a type of energy that is part of the electromagnetic spectrum. This spectrum includes all types of light and radiation - from the X-rays used in hospitals to the visible colours we see every day, even infrared light.

UV light is just beyond the violet end of visible light, beyond the range of our eyes to see which is why we cannot see it. Its wavelengths are shorter than visible light, ranging from about 100 to 400 nanometres (nm), which places it right between visible light and X-rays in the electromagnetic spectrum.

UV light plays a crucial role in the polymerisation process of UV Gels, providing the energy to the initiators to start the chemical process. A well-designed nail product system should provide users with information regarding the appropriate range of wavelengths and the specific nail lamp to use.

When the initiators are exposed to the correct range of wavelengths, it's like turning the key to start a car's engine, initiating the chemical reaction on the nail plate.

There are three types of UV light - UVA, UVB and UVC.

UV lamps used in the nail industry produce UVA, which is the closest to visible light, and safe for skin and nails.

UVB is the type of UV light that causes skin to tan and is used in tanning salons.

UVC is more powerful and dangerous and is used to disinfect and sterilise. Only UVA is used to cure UV Gels. These are safe and do not cause skin tanning or burns.

Original UV nail lamps used a compact fluorescent lamp, a CFL, similar to those used in room lighting. These lamps produced a broad range of UVA wavelengths at very low intensity. This means that they could activate more types of photo initiators used in various different UV gel products but cure slower, usually taking around 2-3 minutes, and they may not cure completely because the intensity is low.

Lower intensity of UV light doesn't work as well for thicker layers of UV gels as it does for thinner layers. Nor does it work well for coloured UV gels, which can hinder UV transmission to the lower layers of the gel. Lower intensity UV means less UV energy to drive the polymerisation process, which can lead to under curing.

These types of bulbs have started to be phased out and replaced by higher intensity LED bulbs.

LED bulbs emit less heat and provide more intense and directional light, consisting of a narrower range of UV wavelengths. This difference is significant when it comes to curing UV gel coatings. A typical LED-style nail lamp can cure at least three times faster while consuming only one-third of the electrical power (wattage) compared to CFL-style nail lamps, resulting in lower energy consumption per second during operation.

Continuous research in UV technology has led to the development of more efficient and safer UV lamps. These advancements not only enhance the curing process of UV gels but also contribute to lower risks, making UV gel treatments an increasingly popular choice.

It's important to note that while UV nail lamps are generally safe, care should be taken, especially with clients who are sensitive to UV light due to medications or other conditions.

A common misconception about UV lamps is the idea that all UV lamps are interchangeable, they are not.

There are many aspects in the design of a lamp relevant to how it cures the UV coating.

- The number and type of bulbs, and the range of wavelengths and intensity they emit.
- The position of the bulbs - LEDs are directional and need to evenly expose all the nails, so each receives the proper intensity of UV.
- The distance of the bulbs from the nails is very important because UV intensity decreases with even small changes in the distance to the fingers.
- The reflection of the lining of the inside of the lamp. As nails are curved it usually helps to have the UV light bouncing off surfaces, so it hits all the sides of the nails, increasing the intensity of UV onto the coated nail plates.
- The electronic components used inside the lamp have a tremendous effect on the intensity of the UV that is emitted. Low quality components will fail to perform over time or may emit less UV, while high quality components ensure better performance over time and are much longer lasting.
- Even the longest lasting LED style UV nail lamp will have to be replaced. It's a common marketing trick to say these lamps will last 10,000 hours. However, the electronic components are not likely to last more than a few years.

Many manufacturers talk about the wattage of a UV lamp. This has no relevance to the amount of UV light that the lamp emits, which is called the "irradiance" in technical terms (aka intensity). The wattage is a measurement of how much electricity the lamp needs to work. Therefore, higher wattages mean it will cost more to use the lamp, since it consumes more electricity. It does not mean the lamp produces more UV.

Also, it is very important to understand that two lamps with identical wattage, can produce completely different amount of UV and different wavelengths, as well. A commonly used marketing trick is to promote the wattage as being an important factor. **A nail lamp should never be purchased solely based on the wattage. That could be a costly mistake that can cause the products to be undercured. Beware of tricky marketing language.**

It is important to understand BOTH the UV range of wavelength's produced and their intensity must be properly "matched" with the chemical composition of UV gels in order to ensure proper curing. Bulb condition is vital to the success of gel enhancements. UV gel lamps that rely on the older CFL technology become ineffective many months before they burn out. After about six months of normal use, a CFL bulb has less than half its original UV energy. If the product seems to set slower than normal, consider a replacement UV lamp. Dirty CFL or LED bulbs also lower UV strength. Clean the bulbs whenever needed. If they become too dirty to clean, replace the UV lamp. Each lamp type, whether LED or traditional, has unique bulb requirements that must be adhered to for consistent results.

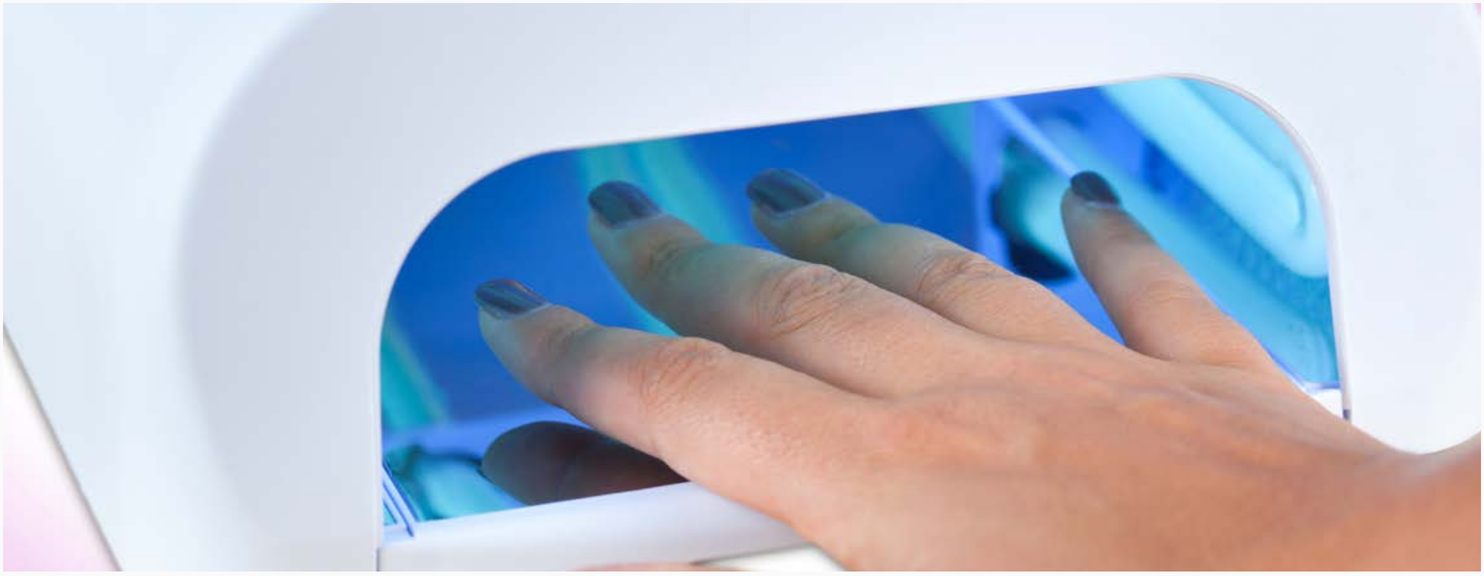

Figure 8: Match UV wavelength, intensity and time under the lamps with the UV gel for proper curing. Maintain and clean lamps regularly.

Allergens in UV Gel

UV gels commonly contain acrylates, a group of chemicals from the acrylic family known for their strong bonding properties and durability in nail products.

These acrylic family ingredients, such as acrylates and methacrylate are integral to the gel's ability to adhere to the nail and maintain a long-lasting finish.

However, some are they are also recognised as potential skin allergens.

The allergenic potential of acrylates arises from their reactivity, which can lead to skin sensitisation. When uncured acrylates come into prolonged or repeated contact with the skin, they can cause allergic reactions.

This is particularly true when they have been applied improperly, where the gel touches the skin and/or is not properly cured under UV light.

Uncured methacrylate or acrylates on the skin can lead to dermatitis, which is characterised by redness, itching, water blisters or swelling. Repeated exposure can increase the sensitivity, leading to more severe reactions over time. If these gels remain on the skin for prolonged periods before being removed, it can expedite the development of skin allergies.

Everyone needs to be aware of these risks and apply UV gels carefully to minimise skin contact, especially with uncured products. It is easy to avoid adverse skin reactions if the products are used properly, as previously described.

Identifying Allergic Reactions to UV Gels

One of the earliest signs of an allergic reaction is redness, itching and swelling of the skin surrounding the nail plate. This can extend to hands and arms, as well. Allergic reactions often cause an itching or burning sensation. This discomfort is a key indicator and can occur even without visible skin changes.

In more severe cases, blisters or lesions may form around the nail area, indicating a more intense allergic response. Skin can also crack, peel or flake.

Note: allergens only affect living skin.

Distinguishing these symptoms from other nail issues, such as infections or reactions to other substances is crucial. Accurate identification involves considering the timing of symptoms relative to UV gel application and ruling out other potential causes. Medical advice should be sought. If allergic reactions are suspected, it is advisable to cease the use of all products and consult a dermatologist for proper diagnosis and treatment.

Nail professionals must always avoid prolonged or repeated contact with oligomers and monomers contained in nail products as many types are known allergens and may cause an unwanted allergic skin reaction that can become permanent, ending a career in the nail industry.

It should also be noted that due to the widespread use of acrylic in dentistry and medicine, developing sensitivity to acrylic can have broader implications beyond your choice of nail polish.

Prevention Strategies

The risk of allergic reactions can be significantly minimised by following the manufacturers' instructions, ensuring a safer experience for both clients and nail technicians.

- **Proper Application Techniques:** Ensure UV gels are applied precisely, avoiding skin contact. Avoid overly thick layers and apply carefully to the nail plate only.
- **Avoiding Skin Contact with Uncured Gel:** Prevent uncured gel from touching the skin. This minimises the risk of sensitisation aka allergic skin reactions.
- **Quality Products:** Choose high-quality UV gels with a proven track record of causing fewer allergic reactions. Products from reputable brands often have more stringent quality control and come with full instructions on use and as a 'system'.
- **Education and Training:** Continuous education on product usage and safety for nail technicians is crucial. This includes understanding the chemistry of the products and the correct use of UV lamps.
- **Personal Protective Equipment (PPE):** Use appropriate PPE, such as gloves, to reduce direct skin exposure to allergenic substances in UV gels.
- **Regular Cleaning of Equipment:** Keep all nail equipment clean to prevent cross-contamination.
- **Client Consultation:** Conduct thorough consultations with clients to understand any history of skin allergies or irritations/sensitivities and to inform them about the products used. thorough consultations with clients to understand any history of allergies or sensitivities and to inform them about the products used.
- **Ensuring a proper cure:** Following the nail system and ensuring a proper cure is one of the ways to prevent allergens being released when being filed or soaked off.

UV gels can be under cured, over cured or properly cured. Monomers left in the nail product may cause allergic reactions. Several factors determine the degree or percentage of cure:

- Thickness of the gel layer.
- Length of cure.
- Wavelength of UV lamp/condition of bulb.
- Intensity of UV produced.
- Type of oligomer used in the product.

Blended into the UV gel are photo initiators which are activated by UV light energy. Once activated initiators break apart to form “free radicals”, which are highly energy fragments that trigger the reaction - polymerising the monomers or oligomers into the long, tangled chains that create the solid polymer that coats the nail plate.

Photo initiators need 3 things to create a proper cure:

- the correct range of UVA energy wavelengths.
- the correct intensity of this energy or irradiance.
- the correct amount of time of UVA exposure.

Studies have shown that different types of UV nail lamps, including both LED and traditional fluorescent lamps, vary in their UV output. It's vital for nail professionals to match the lamp's wavelength and intensity with the specific requirements of the UV gel product to achieve optimal curing and avoid issues such as under or over curing.

When a UV Gel product is applied to the nails, placed under the UV lamp and the timer button pressed, UV energy is absorbed by the photo initiators inside the coating. It’s initially a very fast reaction. Within 10 to 15 seconds 25-30% of the overlay has formed a tangled web and begins to feel hard. After that it slows down slightly but not much.

Once the coating is 50% cured the nail coating will harden and may feel like it's hard enough to be filed. But beware - it isn't properly cured! This can be the risky period for any nail technician! If the incorrect UV lamp is being used for the specific product, the wavelength range or intensity may not be correct, so undercuring becomes more likely to occur. The UV Gel will feel hard, which is different that properly cured. It isn't properly cured.

You must make sure you are using the correct wavelength, intensity and time for the product. If the correct UV nail lamp is used for the specified time, the nail coating will cure to at least 80% of all the monomers and/or oligomers joining into polymer chains, which is considered to be a 'proper cure'. This will result in a coating with good strength and durability, acting as it was designed to.

A Proper Cure can only be achieved when the UV gels are properly applied, and the correct UV Lamp is used for the correct length of time. A proper cure is the best situation for both your client and you; and will provide your client with the results you have promised and with a good measure of safety added.

Proper curing is said to occur around 80-90% (depending on which expert you ask) throughout the coating by the time the client leaves the salon. Another 3-5% can happen over the next day.

It is important to know that a 100% cure will never be achieved. Because some oligomers and monomers become too tangled up, entrapped and unable to do any more that wiggle a bit, but not enough to find other partners to join with.

However, above 80-90%, this won't matter to the safety or performance of the coating. It will still be properly cured.

‘Under curing’ is unfortunately, far too common.

For example, the UV Gel may contain a photo-initiator that absorbs a different wavelength range than your nail lamp produces, or if the intensity of the wavelengths is too low or if not enough UV exposure was allowed to ensure proper curing or if the nail coating was applied too thickly, or all of the above! This is especially true for coloured UV gels since colourant molecules can block and prevent UV light from penetrating deep enough into the coating. Blacks, reds and brown colourants block more UV light than blue or white, making them harder to properly cure.

Another major reason for an improper cure is using too thick of a layer and high viscosity UV gels are inherently more difficult to apply thinly so an improper cure becomes more likely. With thicker products, much greater attention must be paid to avoiding under curing. As a rule, the thicker the coating (or the more highly pigmented), the less efficient the cure. It is much better to use three or four thin coats rather than one or two thick coats. Thinner coats allow more light to penetrate the layer.

A client may worry about the time their nails are under UV light. In-depth research has demonstrated that a UV nail lamp poses minimal health risks compared to direct sunlight exposure. This finding is pivotal for addressing safety concerns, as it underscores the low risk associated with the proper use of these lamps in professional nail care.

Remember: as a UV gel coating feels hard at 50%, you may think that the coating is properly cured but it isn’t! There is a long way to go.

If the nails are removed from the lamp, polymerisation crawls to a stop and the remaining 50% of the uncured ingredients (monomers and oligomers) are trapped inside the coating. They will stay there until the coating is removed.

The dusts and filings will be filled with uncured ingredients, which can increase the risks of developing permanent allergic reactions to those uncured ingredients. Since these ingredients may be found in other UV gels, those products will also trigger allergic reactions, even though they may have never been used before.

The longer the enhancements remain in the UV light, the more completely they cure.

More UV light means less uncured oligomer and stronger nail enhancements. Always use a timer to ensure the correct UV exposure. Never shorten the recommended time. If removal is done by soaking, then the unreacted ingredients will be released into the solvent to cause skin overexposure.

Figure 9: During soak-off removal, unreacted ingredients release into the solvent, risking skin overexposure to allergens. A proper cure minimises the risk of unreacted monomers remaining in the nail, enhancing safety.

It is possible to 'over cure' a UV product. This can happen when the UV energy is too intense, and the photo initiators cause the reaction to release far too much heat in too short of a time. This will result in your client feeling too much heat on the nail bed.

Excessive heat can cause burns to the nail bed and cause the nail plate to separate to form an air space. This opening is prone to infection and eventually, the nail bed may become permanently damaged.

This over curing and the resulting burst of heat is usually referred to as a 'heat spike'. Whenever the client can feel the intense heat on the nail bed, this is a potentially risky situation that should always be avoided and immediately corrected. Find the reason and eliminate it.

Figure 10: A heat spike can cause burns, nail separation, infections, and permanent nail bed damage. Following a nail system carefully can significantly reduce the risks of over-curing and associated damages.

Over-curing can also occur if an overlay is applied too thickly or if the UV intensity is too high during the first few seconds of curing the applied product. The answer is to avoid applying layers that are too thick and always use the correct UV nail lamp, one that is compatible with the gel. Thinner layers cure more efficiently than thicker layers.

If the client's nails are naturally thin or have been overly abraded with a file, bit or buffer, it will be easier for the heat to pass through a thin nail plate to the sensitive structures below. Also over-filing the nail plate can friction-burn the tissue of the nail bed making it much more sensitive to heat and pain.

Overly aggressive filing, buffing and over thinning of the nail plate are some of the most common problems in the nail industry are also likely to intensify pain from heat spikes.

The majority of UV gels have a sticky or 'inhibition' upper layer after the final cure in the UV lamp. This is because oxygen inhibits the polymerisation process at the surface, therefore air will prevent the surface of these UV gels from hardening, even though the underlying layers may be properly cured.

This sticky layer needs to be carefully removed, wearing solvent-resistant disposable gloves to avoid skin contact.

It is soft, because this layer is only about 35-45% cured. Removal is best achieved by an alcohol such as isopropyl alcohol (IPA). Acetone is too aggressive for this use and can damage and weaken the underlying nail coating surface, while IPA will not damage it. Don't use a cotton ball and no gloves, or over exposure can occur in the areas of contact.

Care should be taken during this removal to avoid allowing the inhibition layer to come into contact with the skin as these contain a high percentage of unreacted ingredients, and some could be skin allergens. It is good practice to wear gloves when wiping the cured coating with a cleanser or solvent to avoid skin contact with the unreacted ingredients.

Some UV gels do not have a sticky layer. These are often called 'tack free' or 'no wipe'. They are useful when using pigments or other similar nail effects but are not necessarily the best to use as a general top coat.

Tack-free gels cure more quickly to prevent surface inhibition, but they can become much hotter during cure and can have a higher potential to cause adverse skin reactions, so special precautions are in order. Even greater attention to proper curing with the correct nail lamp and proper cure time, and avoidance of skin contact must be observed.

These 'tack-free' gels use acrylate instead of methacrylate, which cures more quickly but can have a greater tendency to cause adverse skin reactions, also these tend to become much hotter during cure and tend to discolour more easily, so most manufacturers opt toward formulas that have an inhibition layer.

They become hotter because they polymerise quickly, which releases heat more rapidly causing the temperature of the nail bed to skyrocket to potentially harmful levels!

UV Gel Types

There are many different UV gel products available today, but three main categories: UV Gel Polishes, Soak off Gel Overlays and Hard Gels.

Ingredients in the products determine their viscosity. Low viscosity products will be runny while high viscosity products are much thicker. Other added ingredients are used to modify flexibility, surface hardness and colour. Emerging research has identified that the efficacy of UV lamps in curing different types of UV gels, like hard gels, soak-off gels, and UV gel polishes, is influenced by their specific chemical compositions. This underscores the importance of selecting the right lamp type for each gel variant to ensure optimal curing and longevity of the nail treatment.

UV Gel Polishes

These are low viscosity, coloured products designed to take the place of traditional nail polish for natural nails. They appear to 'dry', but they do not. They harden by polymerisation, just like other UV cured products, using many of the same acrylic ingredients, and are designed to last 2-3 weeks. They aren't as easily removed as traditional nail polish.

Often used as a coloured overlay for nail enhancements, as it doesn't smudge, UV Gel Polishes have become popular for a number of effects and nail art, and is a good service for those only interested in natural nail services, though these are perfectly suitable for applying over any type of artificial nail.

Some brands of UV Gel Polish use the marketing term "hybrid" which simply means the UV gel contains solvents designed to evaporate away during the curing process. This can improve the products flow onto the nail plate and facilitate easier removal. A non-hybrid UV gel with no evaporating solvents will take longer to soak off.

Both types appear to work well and can offer clients the colour and protection they need on their nails.

Soak Off UV Gel Overlays

These have a wide variety of viscosities that may or may not be coloured. They are essentially the same as UV gel manicure products, just formulated to provide the natural nail with extra strength or used as a nail enhancement, to give the nail extra length either by sculpting it on a form (a product that provides the platform to build a nail extension on, which is then removed) or over a plastic tip that provides the length required.

These products require some extra training as they require a bit more understanding and practice to manipulate them into the best structure to provide strength and aesthetic value for different nail shapes.

In some cases, these types of UV curing products can be made to appear much thicker, by pre-blending them with acrylic powder. These types of products have many names but are not different. They are merely a thicker mixture of UV gel, so they will require a slightly different application technique.

As with all UV gel systems, care must be taken that the overlay is applied thin enough for the UV light to penetrate all the way through and this is especially true for this type of product as it can be applied very thickly and is opaque.

Too thick of an overlay is a major reason for under curing, causing problems ranging from lifting to discolouration to permanent allergic reactions.

'Hard Gel'

The 'Hard' here actually refers to the difficulty in removal rather than flexibility. Hard Gels can have a wide variety of flexibilities, especially if undercured. Undercuring makes hard gels become more flexible, which of course should be avoided, since this makes the coating less durable and increases the risks of adverse skin reactions. Soft Gels are designed to be more easily attacked and dissolved by common removers, while Hard Gels are less susceptible to solvents such as acetone.

Figure 11: Regardless of UV gel type, handle with care, cure as instructed, and remove safely to manage and reduce your allergen your alle

Understanding Ingredients and Reactions

Remember: UV gel nail products consist of a complex mixture of chemical compounds that require careful handling. The primary ingredients are acrylic-based monomers and oligomers, which undergo polymerisation under UV light to form a hard nail coating. Polymers and oligomers are potential skin allergens. Knowledge, safe handling and safe application of these ingredients is crucial for nail professionals to understand potential allergic reactions and the importance of accurate application to avoid skin contact.

Importance of Safety Measures

Safety measures are paramount when dealing with UV gels and lamps. The risk of overexposure to UV light, though minimal, can be further mitigated by educating clients on the use of personal protective equipment like UV-blocking gloves or simply covering the back of the hand with a cloth. Proper ventilation in salons is essential to minimise inhalation of fumes and dust. Additionally, understanding the correct use of UV lamps, including bulb replacement and maintenance, is vital to prevent over or under curing of gels.

Educating Clients for Safe Practices

Client education forms an integral part of nail care safety. Professionals should inform clients about the ingredients in UV gels, potential allergens, and the safe use of UV lamps. Transparency about product composition and safety practices fosters trust and ensures a safe salon experience.

Nail Health

The health of natural nails should not be overlooked. Nail professionals should be adept at recognising signs of nail infections or allergies and advise clients to seek medical attention accordingly. Regular training on health and safety protocols is essential to keep and maintain best practices in nail care.

Summary

In this journey through the world of UV Gel nail systems, we have explored the science in every bottle of UV gel.

Covering the basics of acrylic chemistry and the polymerisation process, this eBook has aimed to provide you with an in-depth understanding of UV gels.

The acrylic family plays a pivotal role in the nail industry, offering versatility and strength, but also requiring a keen awareness of safety and potential allergenic responses.

The polymerisation process, which lies at the heart of UV gel technology, transforms liquid monomers and oligomers into solid, durable polymers, enabling the creation of nail enhancements.

The role of UV light in this process is essential, as well as the correct UV lamp, ensuring that the specific wavelengths of light are matched to the photo initiators in the gel.

This matching is crucial for achieving a ‘proper cure’, avoiding the pitfalls of over curing or under curing, which can lead to weakened nail coatings or even damage to the nail and skin.

There is a diversity of UV gel products available today, from UV Gel Polishes to Soak-off Gel Overlays and Hard Gels, catering to different needs and preferences. Understanding the properties of these gels, including their viscosity, flexibility, and curing requirements, is essential for both nail professionals and enthusiasts to achieve the best results.

Summary

The world of UV gels is a testament to the incredible advancements in cosmetic chemistry and technology.

As we conclude, remember that the key to mastering UV Gel nail systems lies in understanding and respecting the science behind them. Understanding the unique properties of UV nail lamps, including their varied wavelength ranges and intensities, is essential for nail technicians.

This knowledge allows for precise application techniques, ensuring that UV gels are cured to perfection, thus enhancing the durability and aesthetic appeal of the nail treatment.

By following manufacturer instructions, using the correct equipment, and staying informed about new developments, you can ensure that your work not only looks spectacular but is also safe and durable.

You can advise clients about the safety of UV nail treatments and dispel myths related to UV exposure.

Whether you are a seasoned professional or a passionate hobbyist, we hope this eBook has enriched your knowledge and appreciation of UV Gel nail systems.

May your journey in the world of professional nail care be filled with discovery, creativity, and success.

Acrylics
A group of many different chemicals used to create plastic materials, widely used in nail products and various industries.

Allergens
Substances that can cause allergic reactions, relevant in the context of certain ingredients in acrylics.

Catalysts
Substances that accelerate the rate of a chemical reaction, used in the polymerisation process of UV gels.

Cross-Linking
A process where monomers join to form a strong, net-like structure in polymer chains.

Electromagnetic Spectrum
Range of all types of electromagnetic radiation, including UV light.

Initiators
Substances that trigger the polymerisation process in UV gels, sensitive to specific UV light types.

LED (Light Emitting Diode)
A type of bulb used in UV nail lamps, known for energy efficiency and intense, directional light.

Monomers
Small molecules that can join together to form polymers.

Oligomers
Short chains of monomers used in UV gels to enhance curing efficiency.

Polymerisation
The chemical process where monomers and oligomers join to form long polymer chains, solidifying UV gel.

Proper Cure
The ideal curing state in UV gel application, is where about 80% of the gel is polymerised.

UVA, UVB, UVC
Different ranges of ultraviolet light wavelengths; UVA is used in UV gels, UVB and UVC have higher energy and potential risks.

UV Intensity
The amount of energy per unit area that the UV light emits, crucial for the proper curing of UV gels.

Viscosity
A measure of a fluid's resistance to flow, relevant in the context of the thickness or thinness of nail gel products.

Wavelength
The distance between successive peaks of a wave, is particularly relevant in the context of UV light used to cure UV gel products.

About the Experts

The content presented in this eBook was provided by our team of world-renowned professionals at NailKnowledge; highly experienced individuals dedicated to advancing the field of nail care and education:

Doug Schoon

Doug Schoon is an internationally recognised scientist, author, and educator with over 30 years of experience in the cosmetic, beauty, and personal care industry. He is best known for his expertise in nail care and product chemistry. Doug holds a degree in Chemistry and is renowned for his in-depth knowledge and research in the field.

Marian Newman

Marian has worked in every aspect of the nail industry since opening a 'nails only' salon in 1987. Author, teacher, brand educator, she was regarded as one of the top nail practitioners in the world, with a long history of working with some of the world's leading designers, as well as the London, New York, Milan and Paris fashion shows.

Vitaly Solomonoff

A cosmetic chemist and formulator with a background and experience in clinical medicine (dermatology), Vitaly is an educator and international nail judge.

Tracy Anne Shelverton

Tracy is a hand healthcare specialist. She specialises in the anatomy and pathology of the hands and nail unit. Tracy is a teacher for Oncology Hand Care and registered OHV'r at IKNL and Kanker.nl

About NailKnowledge

Your Source for Nail Education and Inspiration

NailKnowledge is on a mission to revolutionise the standard of education within the Nail Industry - to support Nail Technicians throughout their careers, empower nail enthusiasts, and ensure the safest possible nail practice for all.

Why NailKnowledge Matters

In recent years, we've witnessed a rise in allergies among both nail technicians and clients. Additionally, the market has been flooded with cheap nail products from overseas, often lacking brand education or quality standards. In this ever-evolving landscape, our mission has never been more important.

Expert Collaboration for Quality Education

To achieve our mission, we've assembled a team of worldwide leading experts in the nail industry. This collaborative effort, coupled with the skills of talented animators and designers, allows us to create high-quality educational content that will transform the way both Nail Professionals and Enthusiasts learn.

What We Offer

Our courses cover a wide range of topics, including nail anatomy, product chemistry, health and safety, and allergies. Whether you're a Nail Technician seeking to enhance your skills or a Nail Enthusiast looking to deepen your knowledge, NailKnowledge has something for you.

Fact-Based Learning

We believe in fact-based learning that provides you with the latest industry insights and practices. Our flexible, interactive, and visually engaging courses are designed to cater to your specific needs and interests.

Join Us on Your Nail Journey

Visit NailKnowledge to explore our diverse range of courses and eBooks. Whether you're following your passion, aiming to master product chemistry, or seeking additional qualifications to set yourself apart, NailKnowledge is here to support and empower both professionals and enthusiasts in their nail journey.

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