AN INTRODUCTION TO

LASER TATTOO REMOVAL

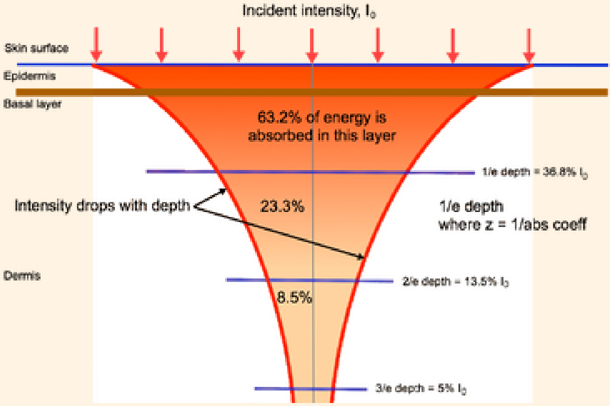
DERMA-LASE
LASER & IPL TRAINING

MIKE MURPHY
LISA MCMAHON

Ed. 1.1

DERMA-LASE

LASER & IPL TRAINING



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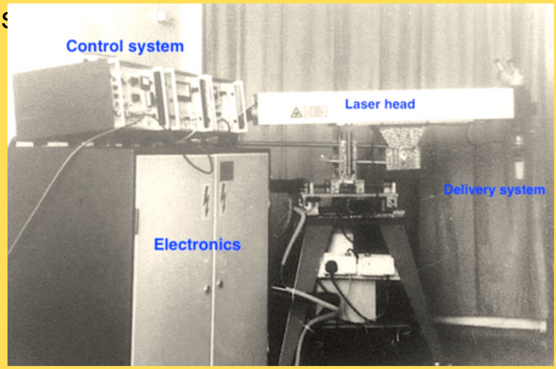
ABOUT US

DermaLase was originally established in 1989 by Mike Murphy with the intention of selling and marketing their Q-switched ruby laser for tattoo removal. This came from the original research program in Canniesburn Hospital, Glasgow in the early 1980s.

Mike joined the research unit in 1986 and helped to develop the removal of paediatric port wine stains using a pulsed dye laser. He also began to design computer models to study the effects of laser energy in the skin - s

develop to this day.

Mike writes blog posts, Patreon articles and scientific papers discussing his research and clinical findings routinely. He presents his work at medical laser conferences around the world and loves a good pint of Guinness.



The original laser system used to demonstrate scar-free, tattoo removal in Canniesburn Hospital, Glasgow in the early 1980s

A very young Mike Murphy with the world's first QS ruby laser used for tattoo removal

Lisa joined DermaLase in 2023 with a background in HR and aesthetics. She runs her own laser/IPL clinic treating hair, tattoos, blood vessels and various other skin problems.

There are many terms and expressions used when describing laser/IPL treatments. It is important to fully understand these expressions, otherwise you may not obtain the best results possible.

Term	What it means...
Wavelength	The wavelength of light is essentially its 'colour'. Visible light exists in the range 400 to around 700 nanometres (nm) – this is from blue to red. Beyond the red part of the spectrum is the near-infrared spectrum, which is invisible to our eyes. But infrared light energy is typically felt as heat.
Energy	The energy of a beam of light is used to increase the temperature of the target – hair, blood, tattoos. The more energy we fire at these targets, the hotter they will become. We measure energy in 'Joules'.
Pulsewidth	Aka 'pulse duration' and 'pulse length'. The pulsewidth is how long a beam of light energy is applied – how long it is 'ON'. This may be from nanoseconds to milliseconds to hours! In some cases, a shorter pulsewidth will generate a higher temperature than a longer pulsewidth, simple because there is less time for the heat energy to 'escape' from the target during the delivery of the pulse. But sometimes, longer pulsewidths are better because they induce more 'cooking' of the target tissues.
Power	Power is simply how quickly, or slowly, we deliver the energy. If some energy is delivered over a short time, then its power is 'high'. If the same amount of energy is delivered over a long time, then it has a 'low' power. We measure power in 'Watts', named after the great Scottish engineer, James Watt.

Term	What it means...
Spot size	When we fire laser energy at skin, or paper or whatever, we can usually see an impression, of some sort. The size of that mark can be considered its 'spot size'. Many lasers fire circular spots and so we can measure their diameter and calculate their area. Some lasers, diodes, and all IPLs output square or rectangular spots – making it easy to calculate their areas.
Fluence	The fluence of a beam of light energy is the energy divided by its spot size area – in other words, the 'concentration' of energy onto the target. Higher concentrations (fluences) will usually induce greater temperature rises in the target. We quote fluences as 'Joules/square centimetre' usually (J/cm^2).
Absorption	When photons of light hit atoms, they will either be absorbed or scattered. Absorption means that energy contained within each photon is 'taken' by the atom, thereby raising its vibrational state (temperature!!)
Scattering	If the photon's energy is not absorbed by an atom, then the photon will be sent on its way – usually in a different direction from its original. This is called 'scattering'. This phenomenon is important in skin treatments because it causes any light beam to spread out once it's in the skin. If you check 'fluence' from above, this means that the fluence decreases, as the light penetrates deeper into the skin.
Penetration Depth	The "useful" penetration depth of light energy is how deep it can go into the dermis while still inducing the desired reaction. This depends on the wavelength, fluence, spot size and pulsewidth.

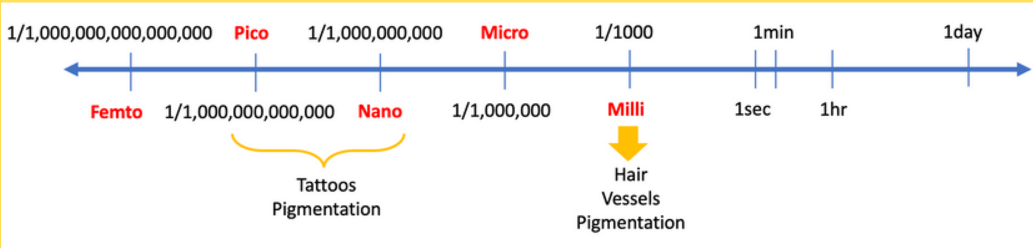
INTRODUCTION

Scar-free, laser tattoo removal has been around since its inception in the early 1980s. Back then, we used a Q-switched ruby laser (694nm) with a 40 nanosecond pulsewidth. This was the first time tattoos were able to be removed without causing permanent scars.

The world's first private laser tattoo clinic was opened by Mike in 1989 in Glasgow, Scotland. Shortly after that, he and his colleagues began to sell these lasers across the world after gaining FDA clearance.

Since then a number of lasers have been introduced into the market including the Nd:YAG with two wavelength (1064 and 532nm) and the Alexandrite laser (at 755nm). Later still, picosecond lasers were introduced utilising sub-nanosecond pulsewidths.

During this time, a number of other skin treatments were developed including the removal of benign pigmentation, carbon facials and skin rejuvenation.



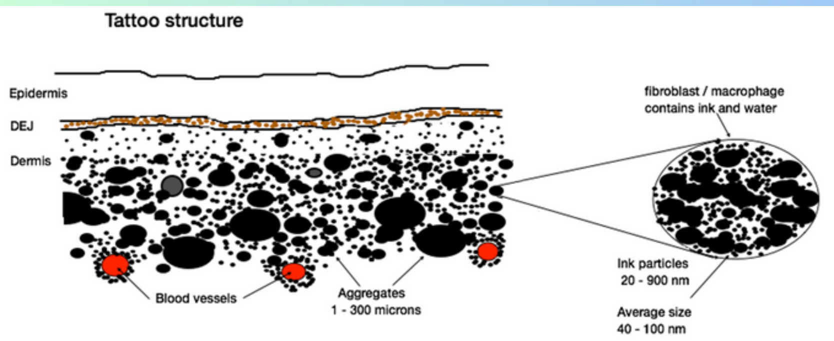
Laser tattoo removal utilises very short pulses of light energy to induce the required reaction in the tattoo ink particles. These pulses need to be in the nanosecond to picosecond range, to ensure that the right temperatures are achieved on the ink particle surfaces. The image above shows where this range lies in the time spectrum.

TATTOOS

What are tattoos?

It is important to understand the nature and composition of tattoos before we look at lasering them.

Tattoo ink particles are absolutely tiny - typically they are between 10 and 100 nanometres in size. That is much smaller than the wavelengths of light that we use to treat them. Their median size is around 40 nm, usually.



About three to four months after injection, most of the ink particles are to be found inside dermal macrophages and fibroblasts.

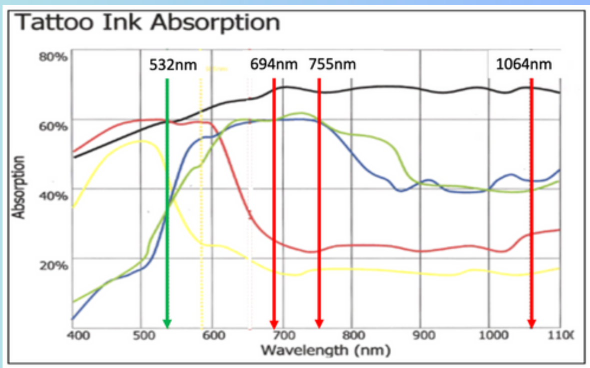
When tattoo ink is injected into the skin, the tiny particles are attracted to each other due to electrostatic (van der Waals) forces. They form aggregates which can grow to very large sizes - up to 300 microns across. On injection, the body tries to remove the ink particles through lymphatic macrophages, mast cells, fibroblasts etc. But, the larger aggregates are too big to physically shift. So, the body generates dermal macrophages which ‘consume’ these aggregates and keep them *in situ*, in the dermis.

Tattoo ink particles generally do not form chemical bonds with their adjacent particles. They exist as a ‘slurry’ - individual particles in water - a bit like sand in a bucket filled with water, at the beach.

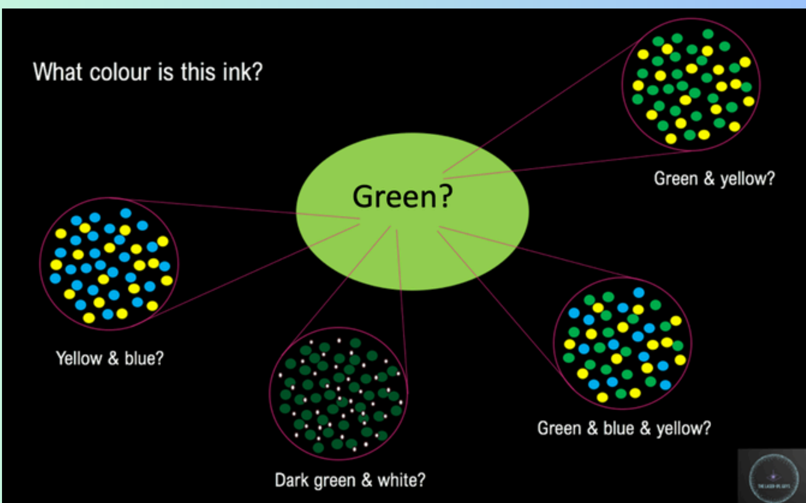
TATTOO INKS

Up until around 2000, most tattoo inks were either organic or metallic in composition. Then the ink manufacturers introduced a new form of plastic inks (polymers) with lots of new, bright and shiny colours.

This made life a bit more difficult for laser operators - since plastic inks are more difficult to shift! These inks usually take a few more treatment sessions than the older, conventional inks.



The real problem for laser operators is that we can never know what is actually in any particular colour. Most tattoo artists mix a number of inks to produce a particular colour that they are after. Consequently, most of the inks we see in a tattoo are actually mixtures of a range of colours - each with their own absorption!

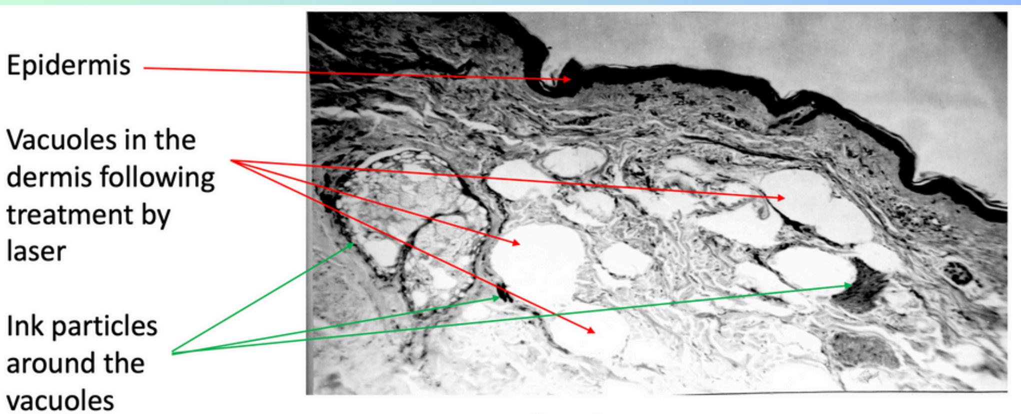


Who knows what those colours really are??? Without microscopic analysis, it is impossible to tell!

LIGHT AND TATTOOS

How does light remove tattoos?

Well, it doesn't! We use light to transfer energy into the tattoo particles. This energy becomes heat which raises the temperature of the surface of the ink particles to around 300 to 400 degrees Celsius. Since the particles are encapsulated inside macrophages filled with water, the heat creates steam near the particle surfaces. Steam expands very rapidly causing the macrophages to burst apart, launching ink particles at very high speeds throughout the dermis. This causes the pain that many feel during treatments.



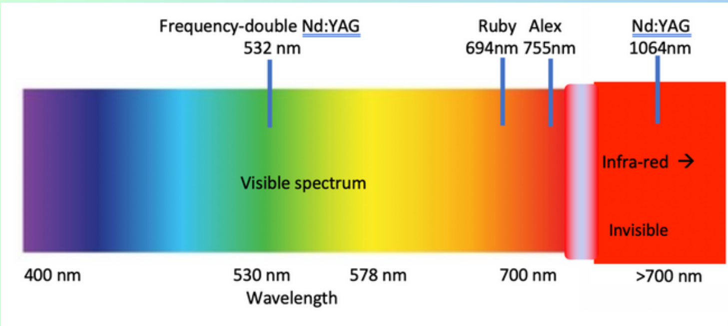
Immediately post-treatment

Histology examined during the original research in the early 1980s clearly show these steam bubbles (above). These are usually called 'vacuoles' and are responsible for some of the 'frosting' appearance we see during treatments.

Research by scientists studying the effect of QS 532nm light energy on gold nanoparticles revealed that these steam bubbles begin to form less than 1 nanosecond after the particles were irradiated. We believe that precisely the same mechanisms occur in tattoo ink particles too.

LASERS

The original laser used to successfully demonstrate scar-free tattoo removal was the Q-switched ruby. Since then we've seen the introduction of the QS Nd:YAG and Alexandrite lasers and the picosecond Nd:YAG and Alexandrite (around 2013).



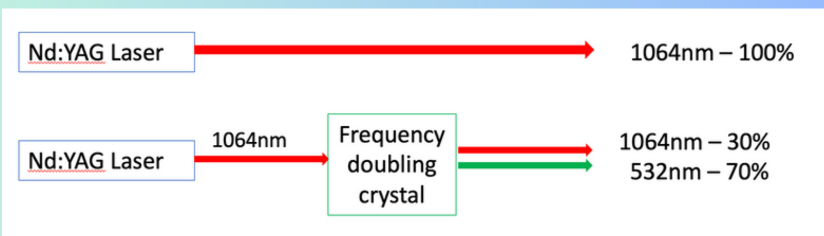
The wavelengths are as follows:

Alexandrite - 755nm
Ruby - 694 nm
Nd:YAG 1064 and 532nm

All, but one, of these are in the red/near-infrared part of the spectrum.

The Nd:YAG laser is unique in that it can be used to generate two wavelengths - very unusual in lasers!! It does this by firing the original 1064nm beam into a KTP crystal, which then 'converts' around 70% (or so) of the energy into the frequency-doubled beam with a wavelength of 532nm.

The remaining 30% is emitted at 1064nm.



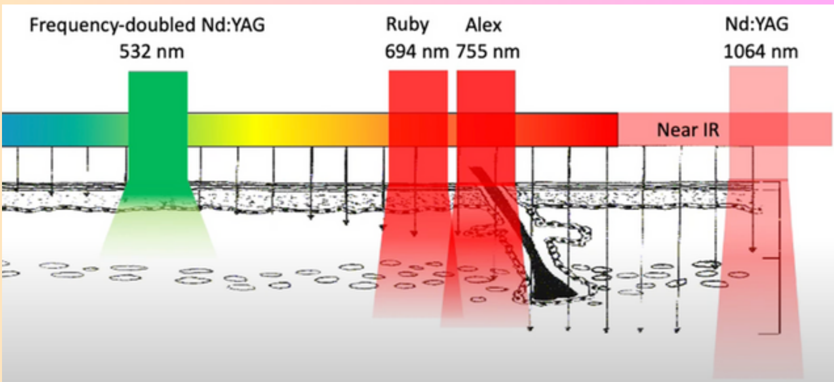
All of these wavelengths are absorbed by ALL ink colours - to some degree. Black inks absorb more strongly than all the other colours. But, contrary to the current consensus, all colours will absorb a percentage of any of these wavelengths, depending on the absorption coefficient.

LASER INTERACTIONS

It is important to understand a bit of physics at this point. The way light interacts with the skin and its constituents is poorly understood - by most people. Yet, a basic understanding will help in many treatments.

When light enters the skin, the photons encounter atoms immediately. There are two possible outcomes from these interactions - either the atoms will absorb some photons, which will raise their temperature slightly. Or, and **much more likely**, the photons will be 'scattered' into a new direction. The skin is a highly scattering medium - virtually every photon will be scattered, many times, before it finally is aborbed by an atom (or, directed out of the skin altogether - this is known as 'back-scattering').

The different wavelengths penetrate to different depths in the skin due to anisotropy. Longer wavelengths penetrate deeper.

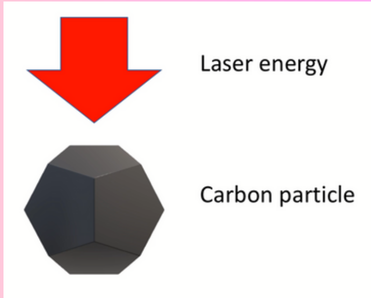


But, changing from one wavelength to another should not be considered a trivial choice! We must consider the ramifications of doing so. 1064nm is a rather 'benign' wavelength - it doesn't really interact much with any tissue!! Whereas, the 532nm wavelength is much more strongly absorbed in both melanin and blood. This means that changing from 1064nm to 532nm will likely cause more unwanted tissue damage, for precisely the same fluence. Plus, the 532nm will not penetrate as deeply as the 1064nm...

THE MECHANISM

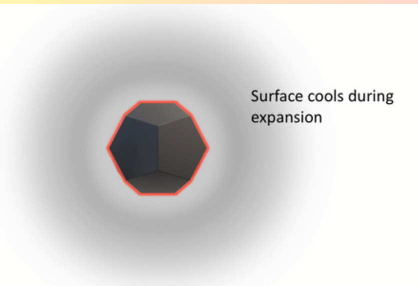
How does laser treatment work?

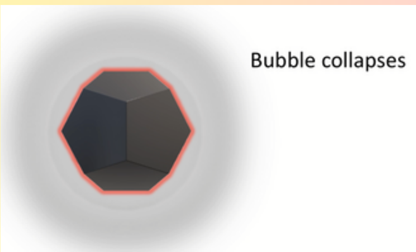
This is how we think this process works...



Every ink particle is contained within a cell in the dermis, and is surrounded by tissue water. The most superficial particles (near to the skin surface) absorb some of the incoming laser energy and become hot, very rapidly.

In doing so, the adjacent tissue water also becomes hot and soon forms steam (in less than a nanosecond!!!)



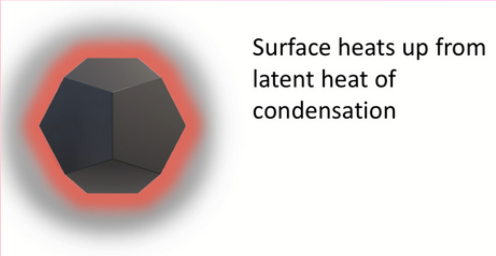


Steam bubbles expand very rapidly – up to 700 metres/second. As they do, the macrophage cells 'explode' and the ink particles are rapidly pushed into the surrounding dermis. In essence, the same conditions that existed immediately after the tattoo was originally formed are recreated by the high-speed ink particles.

This is the cause of the pain felt in these treatments - hot, sharp particles tearing through the skin and nerve tissue.

These steam bubbles effectively form a 'steam mirror' within a few nanoseconds - blocking any further absorption of laser energy. Computer models indicate that only a small fraction of the applied laser energy is actually absorbed by the ink particles.

THE MECHANISM



After a few nanoseconds, the bubble expansion stops and it collapses back towards the ink particle. This returns some of the latent heat energy back onto the particle’s surface, which then re-heats, creating more steam bubbles, from condensed droplets.

This cyclic process repeats a number of times until the heat energy is finally lost to the surrounding tissues through conduction.

It appears that laser tattoo removal is essentially a steam-driven process, thanks to the tissue water surrounding all the particles. These temperatures are not sufficiently high to induce any thermo-elastic or photo-acoustic processes.

The ink particles do not ‘fragment’, as many appear to think. There is nowhere near enough power in this scenario to do that. Instead, the aggregates shatter back into their component particles.

All this merely returns the tattoo particles and skin back to the same state which existed immediately after the original tattooing process. The body then responds by kick-starting the wound response mechanisms to repair the damage and remove the ink particles. This process occurs whether we fire nanosecond or picosecond pulses at tattoos.

HOW DO WE CHOOSE WAVELENGTH?

So, how do we choose the most appropriate wavelength for the target? Well, this is not so obvious!

Firstly, we can never know the actual colours in any tattoo ink, since it is most likely going to be an amalgamation of a number of colours.

Secondly, we have no idea what these inks are made of.

Thirdly, we cannot know (without an expensive spectrophotometer) how strongly those ink colours absorb at different wavelengths!

So it really is a bit of a ‘guess’, plus ‘trial and error’. Research from a Korean study found the results in the image on the right. But, they tested ‘pure’ ink colours from a manufacturer.

Ink Colour	Wavelength
Black	1064/755/694
Green	755/694
Blue	755/694
Red	532
Yellow	532

Real world tattoos will rarely contain ‘pure’ colours - they simply don't. What this means is that you may be treating a ‘green’ coloured ink, which might actually be composed of yellow and blue inks. The blue ink may respond more strongly to your laser wavelength of choice, and fade more quickly than the yellow ink. This apparent ‘green’ ink will then appear to change colour over a number of sessions. The same applies for other colours! In reality, you need to ‘test’ the reaction with different wavelengths to see which might work best, over time.

HOW DO WE CHOOSE FLUENCE?

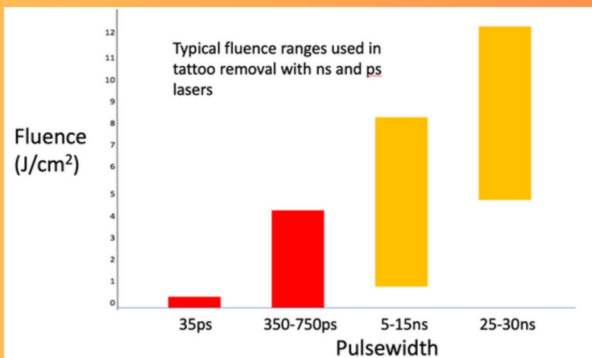
What is the threshold fluence for tattoo removal?

	Required fluences (J/cm^2)			
Ink Colour	532nm	694nm	755nm	1064nm
Black	2.3	2.0	2.0	2.0
Green	4.0	2.3	2.3	3.4
Blue	4.0	2.3	2.3	3.2
Red	2.3	5.4	6.2	5.2
Yellow	3.0	8.0	8.0	8.5

Choosing the correct fluence is very important when treating tattoos. Too low a fluence will not induce the required reaction, while too high a fluence can easily damage the collagen.

The table above shows the ‘threshold’ fluences for a range of ink colours and laser wavelengths. These are the minimum fluences required to stimulate the desired response, but they only apply to the most superficial ink. Deeper ink will require higher fluences.

However, the laser pulsewidth has an effect on the threshold fluences. The image on the right shows how longer pulsewidths typically require higher fluences than shorter ones.



This image (left) shows a test Mike did using a QS Nd:YAG laser on a number of colours. He fired the 532nm beam at 3 J/cm^2 at each colour. We can clearly see that the red ink reacts more than the others, while the light green and yellow hardly react at all. The darker inks (to the left) show some petechia - little blood spots due to capillary damage. These reactions are fairly typical for this wavelength/fluence combination.

NANOSECONDS VS PICOSECONDS

The first commercially available picosecond laser for tattoo removal was introduced in 2013 by an American company. It was an Alexandrite laser at 755nm. A few years later, a picosecond Nd:YAG was launched by another company with both 1064nm and 532nm. Both companies claimed they could treat “all tattoos, all colours”.

A couple of years later, a class-action lawsuit was launched by American buyers who felt that had been “duped” into buying these devices.

The problem appeared to be that insufficient clinic trials had been carried out prior to those claims being made.

An excellent study was carried out in 2018 by a group of clinical researchers, and their findings were very interesting (see table).

In order of effectiveness

	Ink colour:					
Order	**Black**	**Red**	**Orange**	**Yellow**	**Green**	**Blue**
1	1064 ps	532 ps	532 ps	532 ps	755 ps	755 ps
2	532 ps	532 ns	532 ns	532 ns	532 ns	532 ns
3	1064 ns	1064 ps	1064 ps	1064 ps	532 ps	532 ps
4	532 ns	1064 ns	1064 ns	1064 ns	1064 ps	1064 ps
5	755 ps	755 ps	755 ps	755 ps	1064 ns	1064 ns

1: Choi M.S., et.al. “Effects of picosecond laser on the multi-colored tattoo removal using Hartley guinea pig: A preliminary study.” (2018)

They found that their picosecond lasers appeared to generate the ‘best’ results across six ink colours - with three wavelengths - 1064, 532 and 755nm. However, what was most interesting is that they found that the Q-switched 532nm wavelength (labelled “532 ns” above) was the second best in terms of ink clearance, for all the ink colours, except black.

This study showed, clearly, that picosecond lasers are not necessarily the most efficient when treating tattoo inks. A good QS laser can be nearly as good - especially when we consider the prices!

CLINICAL ENDPOINTS

There are only **two** clinical endpoints we should observe:

1: an almost immediate reaction is the erythema (reddening) of the treatment area. This is due to dilation of the local blood vessels in response to the trauma we have inflicted in the skin.

2: a few minutes after the treatment, we should observe some local swelling (oedema) in the tattoo.

Both of these effects can be seen in the photos here.

Frosting, as seen above, is **not** a required clinical endpoint. Often, this is only seen in the first few treatment sessions. It is caused by the formation of steam bubbles (vacuoles) around the ink particles and also due to damage in the melanosomes in the epidermis.

Some people appear to think that we must hear a loud ‘cracking’ sound when treating tattoos. This is just nonsense!! It is absolutely **not required**, and, in fact, is a bad thing. The ‘crack’ sound is generated when small spot diameters are fired at the skin resulting in huge energy and power densities. These densities are sufficient to strip oxygen molecules in the air, of electrons, briefly. That’s what causes the sound - it has nothing to do with tattoos or the skin!!

“DIFFICULT” COLOURS

Some colours are more difficult to remove than others. Why is that?

Well, it is simply down to the ‘absorption coefficient’ of the coloured inks. This is a measue of how strongly the ink particle absorb the laser energy.

The problem is that the absorption coefficient varies enormously depending on the wavelength of the light. So, for example, green ink may absorb red light very strongly, but it will hardly absorb green light at all! This implies that we should only ever use red light on green inks.

Unfortunately, it is rarely that easy. Firstly, we can never know which ink colours are actually in the tattoos - we just cannot differentiate coloured mixtures very well. Secondly, without using the proper equipment, we cannot possibly know how strongly any colour will absorb any laser wavelength.

So, we simply have to ‘test’ the wavelengths we have to hand, and observe which works best. Inevitably, some coloured inks will react poorly, simply because they don’t absorb enough energy. There are two choices now available - either we increase the fluence and see if that works any better; or we change wavelength and hope it is more strongly absorbed.

By kind permission of Billy Shipers, Shipers Laser Tattoo Removal Center,Texas.

Greens and purples are well known to be ‘difficult’ to remove with modern-day laser technology. Those pigments just don’t absorb energy well from the wavelengths we typically use.

But, as we can see above, they can be successfully removed, if treated properly. Billy used a multi-wavelength laser which output 1064 and 532nm from an Nd:YAG laser and a 694nm beam from a ruby laser. By carefully choosing the most appropriate wavelengths and fluences for each colour, he managed to obtain the above, excellent result over 12 sessions.

The truth is, most ink colours can be effectively removed, if treated by a professional with good equipment.

OXIDATION

We often see laser operators talking about “oxidation” when some ink colours change into different colours.

This is quite curious as it is very difficult to determine whether something has actually oxidised!

However, ink colours can change for a number of reasons. The image on the right shows a red iron oxide ink compound which appears to have been chemically altered during the first treatment.

A series of treatments changed the red ink into black, which then faded over subsequent treatments.

In some situations, the colour appears to change simply because one of its constituent inks is fading much faster than other constituents.

Regardless of the reason for any colour change, the important issue is the ability of the new colour to absorb your laser energy. As discussed in the ‘Difficult Colours’ section, this depends on the absorption coefficient and the wavelength used.

Once again, this means that either a different wavelength must be used to tackle the ‘new’ colour. Or, sometimes, a higher fluence is the better option.

SKIN COOLING

Recently, some laser users have been pre-cooling the tattooed areas prior to laser treatment. This appears to help reduce the painful sensations.

Now, this treatment is not regarded as a photothermal process, yet, we do now think it is essentially "steam-driven". Consequently, heat is generated within the dermis and will result in some localised temperature rises in the tissues.

This implies that pre-cooling is actually a good idea, to help minimise any pain associated with those elevated temperatures.

There is absolutely no reason why we shouldn't do this - it will not adversely affect the process at all. If it helps your patients/clients through the treatment session, then why not?

Some of the heat energy generated at the particle surfaces will diffuse into the surrounding tissue - leading to some localised heating.

TIMINGS

When we did the original clinical research in the 1980s, we determined that the ‘optimum’ gap between sessions should be four weeks. This was based, purely, on the appearance of the epidermis after previous sessions.

We published this back in 1990 in a plastic surgery journal. It became the standard timing for nearly 20 years. Then some people noticed that leaving a six week gap appeared to be ‘better’ in that more ink usually disappeared.

That became the norm for about 10 more years. At that point, some people began to leave eight week intervals between sessions, claiming that this longer period was even ‘better’.

It was then we began to wonder what was going on. So, Mike conducted a wee experiment on the tattoo shown here. This belonged to Lisa’s husband, Conor.

Standard treatments, using a QS Nd:YAG laser (nanosecond) were applied to this tattoo, over very long periods of time. The shortest gap between sessions was 9 months, while the longest was two years.

The final result (bottom photo) was after just four sessions. Clearly, leaving longer gaps between sessions results in more ink being removed by the body.

We now recommend leaving three month gaps, to reduce the total number of sessions required.

BAD RESULTS

What happens when things go wrong?

The photo on the right shows what can occur if your patient/client does not follow aftercare instructions. He left the clinic and went to work in a shop where the walls and ceiling were being stripped. The air was obviously full of dirt, dust and other nasty bits and pieces.

His freshly treated tattoo was invaded and infected, even though it had been properly dressed after the treatment. Fortunately, the final result was not too bad, after a few months recovery.

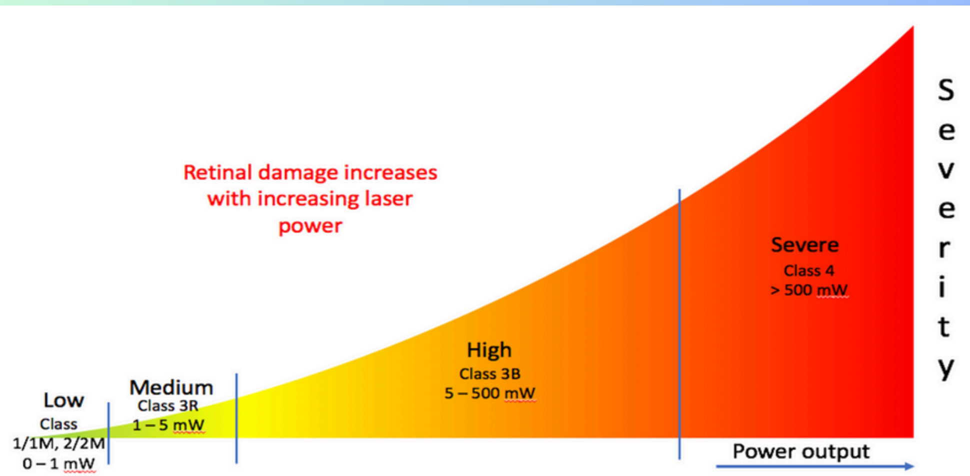
You must insist that your patients/clients follow your post-treatment instructions to the letter!! Otherwise they can easily end up with situations like these...

SAFETY GLASSES

We have to add a section here about laser safety glasses since they are SO IMPORTANT when using QS or picosecond lasers.

You only have one pair of eyes! You MUST look after them.

We have a full section on this topic in our “A Brief Guide to Laser Safety” booklet. This is free to download. Please do.



All Q-switched and picosecond lasers emit very high powered pulses of light - millions of Watts, typically. Some of these are invisible to our eyes, but they are still very hazardous. All these lasers are Class 4 - the most dangerous out there.

Conseqently, you MUST have the correct laser safety glasses for your laser. Those glasses must protect you against the wavelength(s) that you are using, AND to the correct safety level. For tattoo removal lasers, this is usually an Optical Density of 7 or higher. You should see something like “1064nm, 532nm, OD7+”, or something similar on your glasses. If you don’t then **don’t use them**!!!

PMU INKS

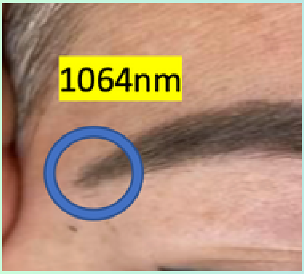
We can also use QS and picosecond lasers on semi-permanent eyebrow make-up. However, many of these inks are quite different to the standard body tattoo inks, in that they are made of a different range of constituents. Consequently, they can also react differently to body tattoos.

We tested some of these inks using a QS Nd:YAG laser at 1064nm and 532nm and made some interesting observations. The images on the right show how two of these inks reacted, to low fluences.

They appeared to become 'lighter' in colour. We suspect that this is not an actual change of colour - but merely a reduction in the concentration of the inks.

Two SPMU inks responded to the laser energy by becoming lighter in colour.

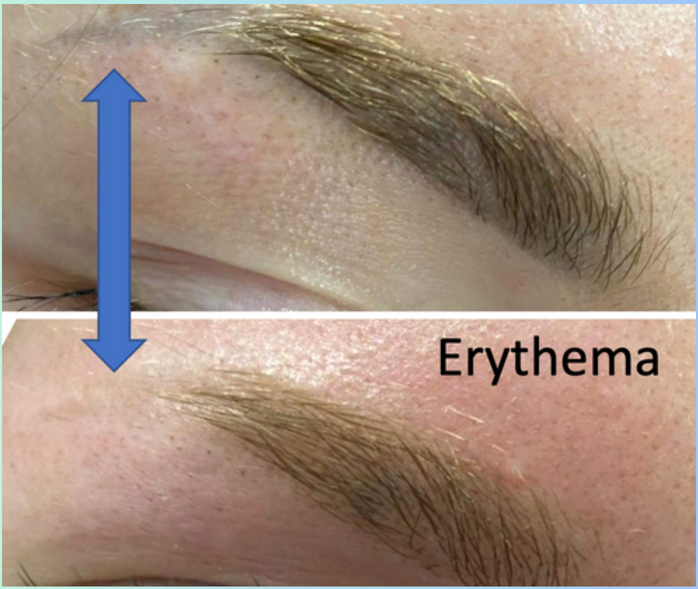
It appears that many laser users automatically change wavelength when they see this sort of reaction in their clients. While this may seem to be the best option, often it is not. If you see a significant colour change in your treatment, then perhaps you should continue with the same wavelength for subsequent treatments.



Alternatively, you could try a simple test as indicated in the images on the left - test patch two separate areas with different wavelengths and see which appears to give the better result.

PMU INKS

Just as with body tattoos, you should expect to see two reactions when treating SPMU - erythema: a reddening around the treatment area fairly soon after lasering; and some oedema: a slight swelling of the treatment area itself.



In some cases, you will see the ink disappear almost instantly - this indicates that there was very little ink there in the first place. This is quite typical with SPMU since the artists usually use much less ink than body tattoo artists (see above photos).

However, there are many reported cases of a 'yellow' residue after laser treatments. This may be due to very low concentrations of ink remaining, which may not react very well to further laser treatments unless high fluences are applied. Or, it may be due to an actual chemical change in the ink resulting in a yellow/orange colour. It can be difficult to tell!

PMU INKS

Not only brows can be treated using lasers, but also lips and scalp 'hair' pigments. Like SPMU, these areas can be treated using QS and picosecond lasers, to varying degrees of success. Just be very careful if treating the lips since there are many capillaries just under the skin surface, which may be easily damaged by the laser energy (especially 532nm).

When treating SPMU you should typically use a relatively low fluence since most of these inks are quite superficial in the skin.

Leave around 4 to 8 weeks between repeat sessions, depending on the individual responses. Most SPMU will be completely removed after around 2 to 10 sessions depending on the depth of the inks.

You might observe colour changes - you can either continue with the same wavelength as before, or change to a different wavelength - it's up to you!

Be aware that the 532nm may also cause vascular damage which will make the treatment area appear red for a few days. Plus, lip liner often turns black after treatment, and this appears to be harder to remove!

You may see a histamine reaction, as with body tattoos. This is usually short-lived and may be treated with over-the-counter anti-histamines.

BOOKS

Mike Murphy has been investigating laser-tissue processes and treatments since 1986. He has published many peer-reviewed papers, articles and books on various topics including the removal of hair, tattoos, blood vessels, pigmentation using lasers and IPL systems.

He continues to research all of these areas and still presents his work at international medical laser conferences.

He has published three books on this subject:

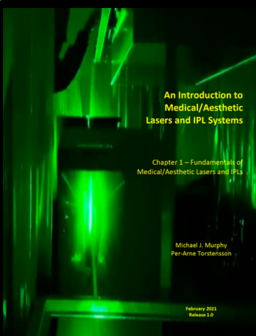
An Introduction to Medical/Aesthetic Lasers and IPL Systems

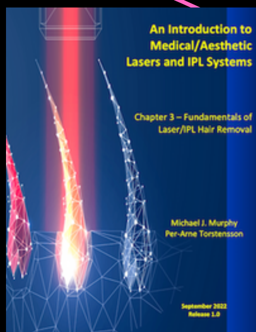
An Introduction to Laser Tattoo Removal

An Introduction to Laser/IPL Hair Removal

This translation was created by a machine. Our apologies if it is not quite correct.

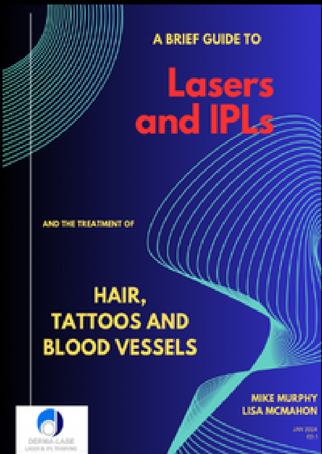
You can find his blog at 'MikeMurphyBlog.com'

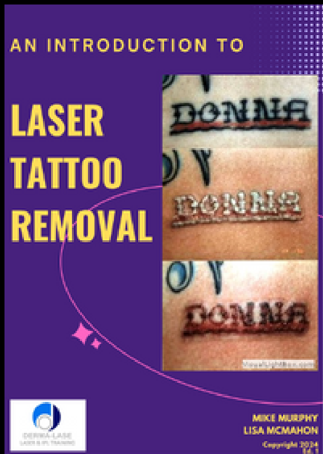


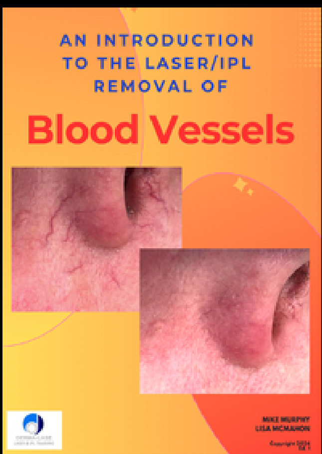


www.DermaLaseTraining.com

Other booklets by Mike Murphy:







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