



# The Science Behind Laser Tattoo Removal

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# Tattoo Physics



- Tattoo ink
  - ✓ Pigment
  - ✓ Carrier (a substance or a mixture)
- Ingredients of the **Carrier**
  - ✓ Ethyl alcohol (ethanol)
  - ✓ Purified water
  - ✓ Witch hazel
  - ✓ Listerine
  - ✓ Propylene glycol
  - ✓ Glycerin (glycerol)

# Tattoo Physics



- Ingredients of the **Pigment**

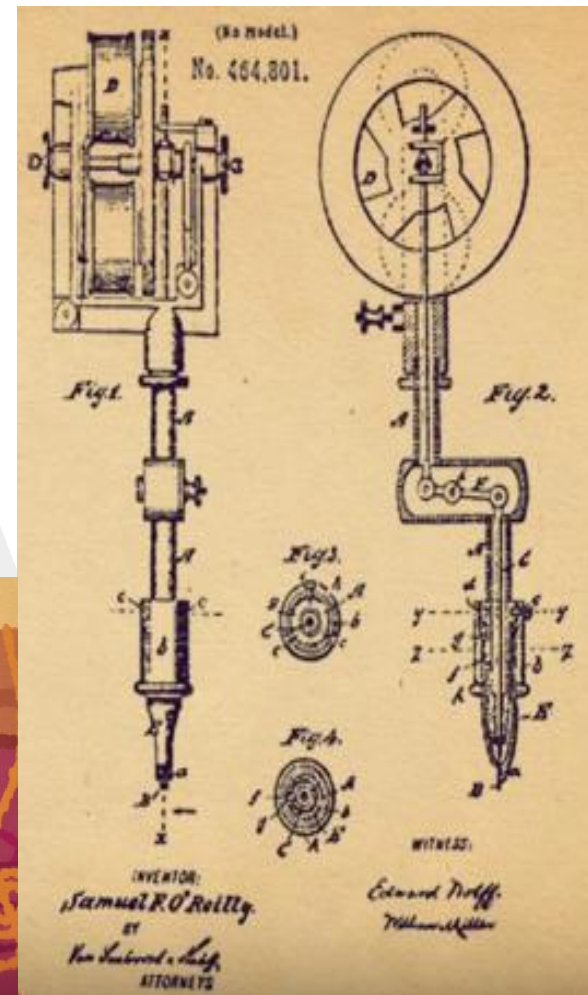
tattoo ink pigments

iron oxide (wustite or magnetite crystals), carbon
iron oxide (ochre)
iron oxide (rust), cinnabar, cadmium red
chrome yellow, cadmium yellow, curcuma yellow
chrome oxide, malachite
cobalt blue, lapis lazuli, azurite
quinacridone, carbazole, manganese violet
titanium dioxide, zinc oxide, lead carbonate, barium sulfate

The image shows a vertical stack of colored bars representing different tattoo ink pigments. From top to bottom, the colors are black, brown, red, yellow, green, blue, purple, and white. Each color bar is labeled with its corresponding chemical ingredients. The top bar is black and labeled 'tattoo ink pigments'. The bottom bar is white and labeled with 'titanium dioxide, zinc oxide, lead carbonate, barium sulfate'.

# Tattoo Physics

- Tattooing machine
  - ✓ **Pierces** at a frequency of 50-3.000 times per minute
  - ✓ Reaches the Dermis
  - ✓ Causes **wounds**
  - ✓ Inflammatory process begins



# Tattoo Physics

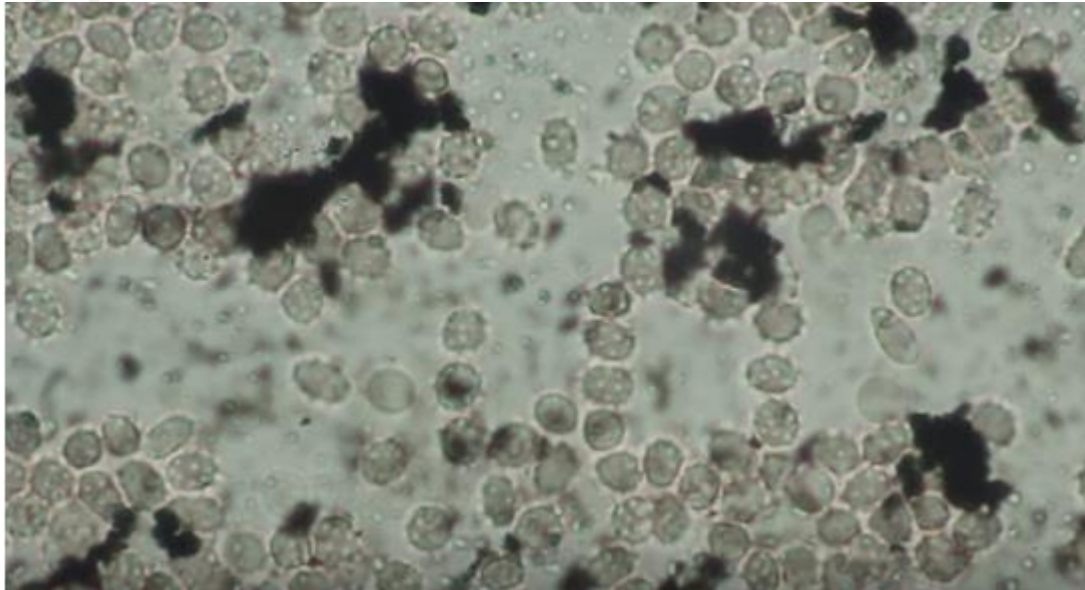


- The Inflammatory Process
  - ✓ Immune system cells (**macrophages**) roll in the site
  - ✓ They **respond** to the substance invading the body
  - ✓ They clean up by **engulfing the ink particles**
- The outcome
  - ✓ Some are **carried back** with the ink particle inside them, into the lymph nodes
  - ✓ Others **remain in the dermis**
  - ✓ Some no-engulfed ink particles are **suspended** in the gel-like **matrix** of the dermis
  - ✓ Others **get soaked into dermal cells** (fibroblasts)

# Tattoo Physics



- That is why the tattoo is **permanent!**



- But how can we get rid of it?

# Laser Tattoo Removal

- Two ways of removing a tattoo

1. **Laser**



2. **Plastic surgeon**

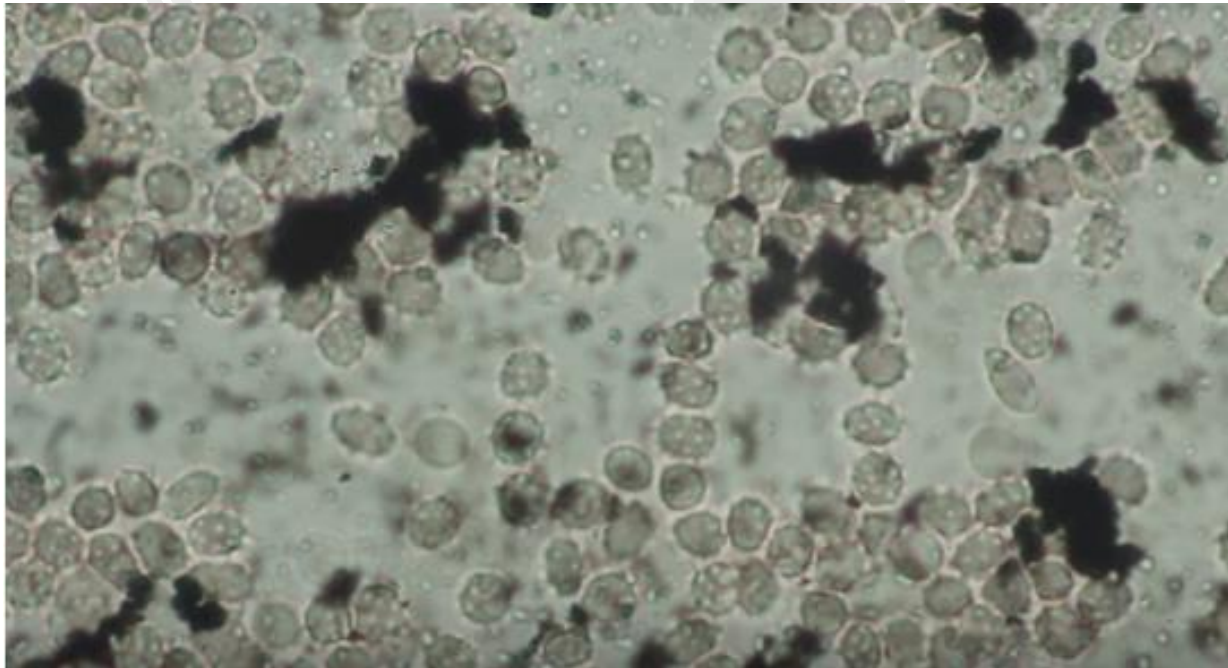




# Laser Tattoo Removal



- What is the **plan**?
  - ✓ Make the ink particles' **size** as small as the blood cells
  - ✓ Macrophages will be able to engulf them



# Laser Tattoo Removal



- What can we achieve by using Laser?  
✓ ***Photothermolysis***



1. Heat up very fast

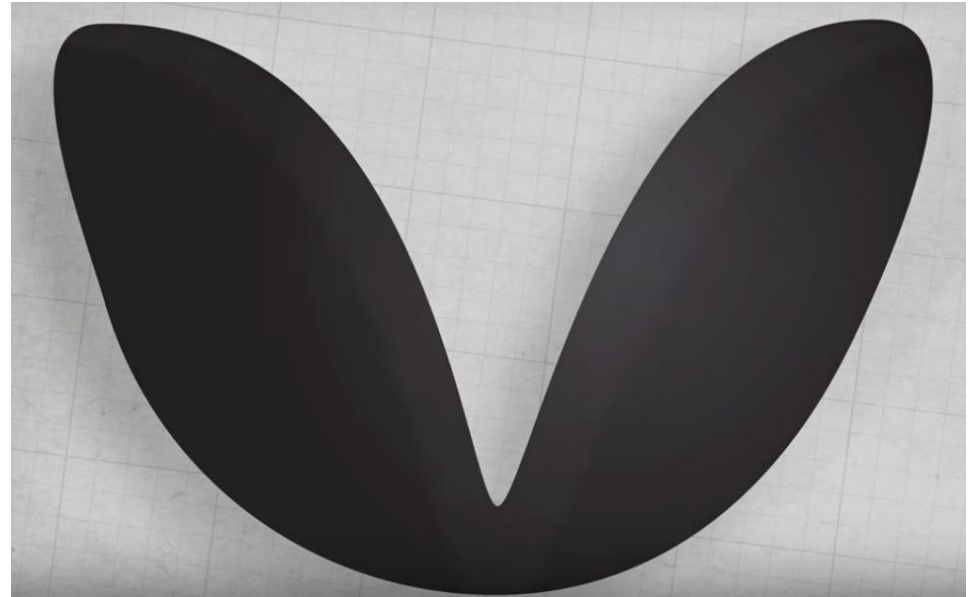


2. Only the one side grows  
due to thermal expansion

# Laser Tattoo Removal



3. The other side remains cool

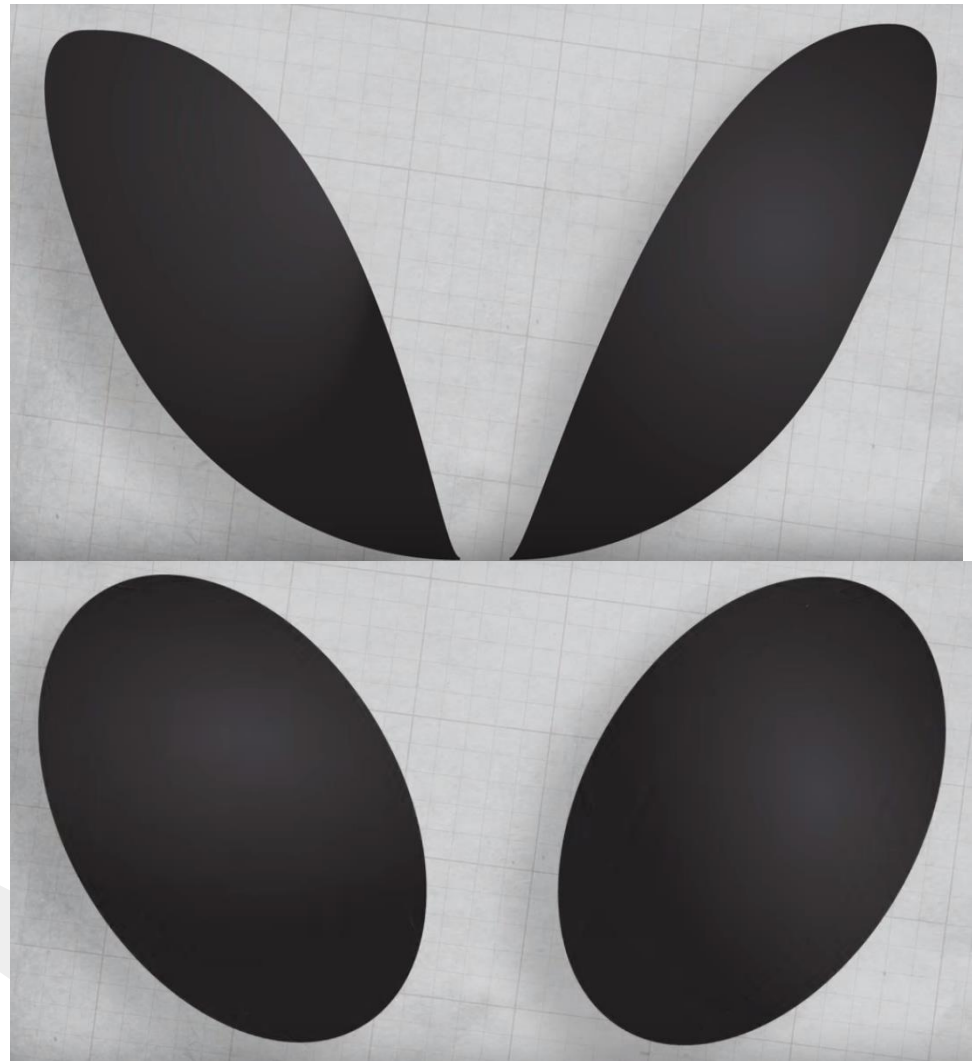


4. So, huge internal stresses are caused

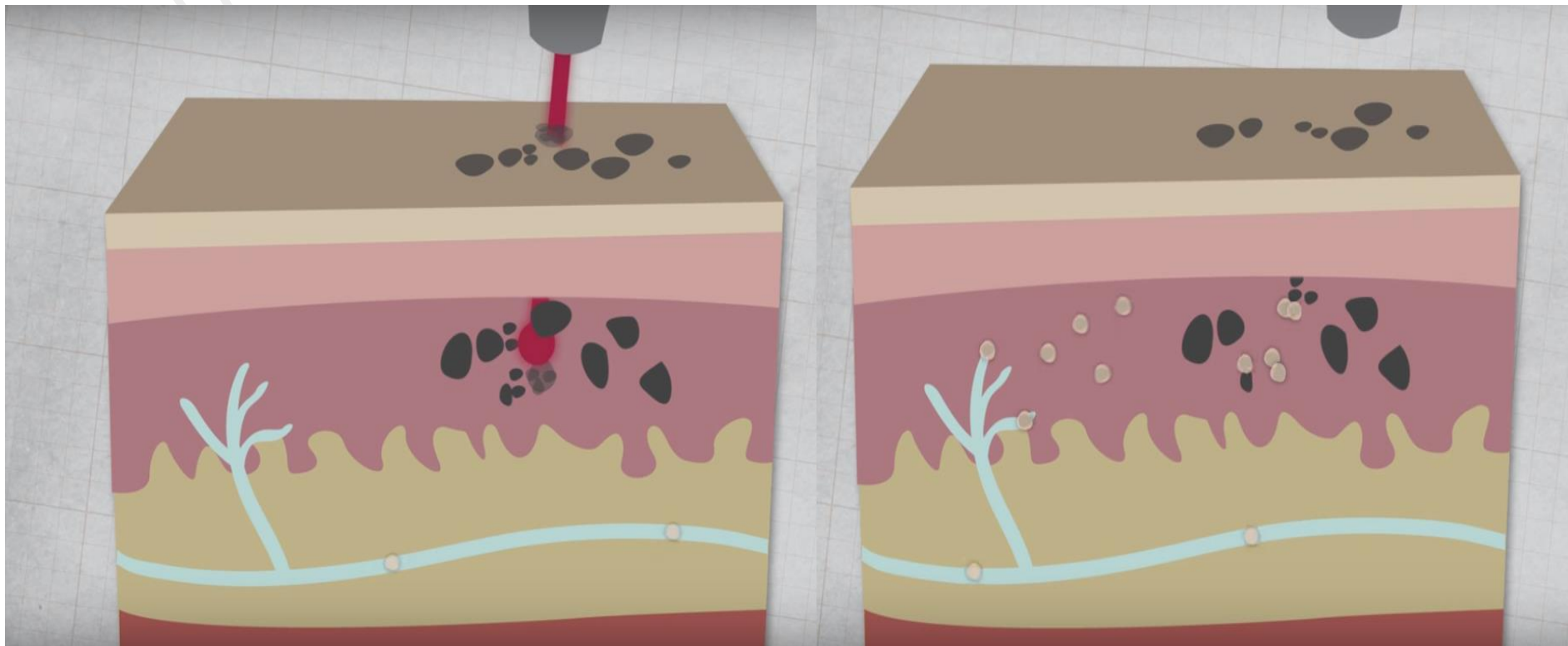
# Laser Tattoo Removal



5. These stresses rip apart the particle



# Laser Tattoo Removal



# Laser Tattoo Removal



- It is a time game!
- ✓ The faster you can heat up one side relative to the other, the more likely you can rip apart the ink.



# Laser Tattoo Removal



- The white effect is called frosting and it only lasts for a few seconds. It is basically a shock wave that is happening at the particle level.



# Q-Switch Yag Laser

- **Nd:YAG** (neodymium-doped yttrium aluminum garnet)
- Nd:YAG laser has  **$\lambda=1064 \text{ nm}$**  and has the capability to **reach deeper layers of skin** tissue than other types of lasers.
- Q-switching makes the laser to **produce laser pulses**.

Nd:YAG produces **2 wavelengths**

- ✓  $\lambda_1=1064 \text{ nm}$  and a second beam of  $\lambda_2= 532 \text{ nm}$  which is useful for superficial skin lesions.
- **Blue, grey** and **black** tattoos can be removed
- Typical settings are
  - ✓ pulse duration: 10 nanoseconds,
  - ✓ output energy: 300-500mj



# PiQo4 Laser



- **Pi** – is short for a picosecond
- **Q** – is short for Q-switched
- **4** – denotes that this laser produces 4 different wavelengths (1064nm, 532nm, 585nm and 650nm)
- The option of larger spot sizes up to 15.5mm

# Human Body Contribution



- **Inflammatory process**
- The **further away from your heart** that a tattoo is on your body, the **longer the process** can take.
- Tattoo removal **results are individualized** for everyone and with each tattoo.
- Your **health** plays a big role on the results you get.

# Pros & Cons

- Pros:
  - ✓ Relatively Painless
  - ✓ It's Non-Invasive
  - ✓ High Success Rate with minimal side effects
- Cons:
  - ✓ Multiple sessions may be required
  - ✓ May Cause Skin Irritation
  - ✓ Risk of Infection
  - ✓ Uneven Skin Color
  - ✓ High Cost

A large, faint, light gray watermark of a butterfly is centered on the slide, with its wings spread and its body and antennae visible. The text "Thank you for your attention!" is overlaid on this watermark.

**Thank you for  
your  
attention!**