SMART MATERIALS

Presentation in Material Science
by Group 1

OUR GROUP MEMBERS

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Smart Materials

51. Balraj Tavanandi

Smart Materials Applications

71. Pranav Walvekar

Chromic Materials

54. Krishnaraj Thadesar

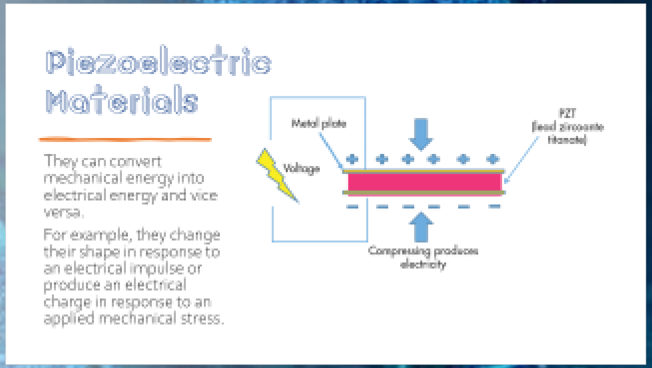
Shape Memory Alloys

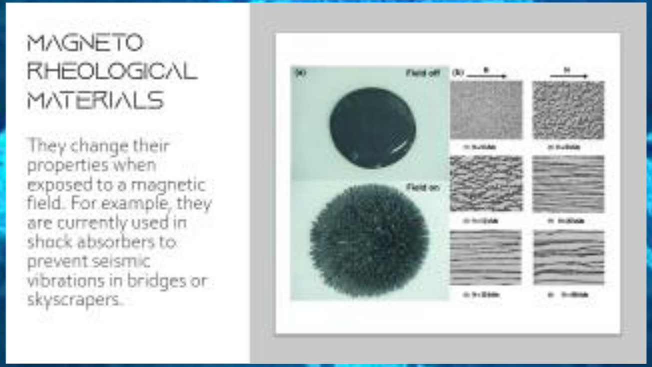
WHAT DO WE MEAN BY SMART MATERIALS?

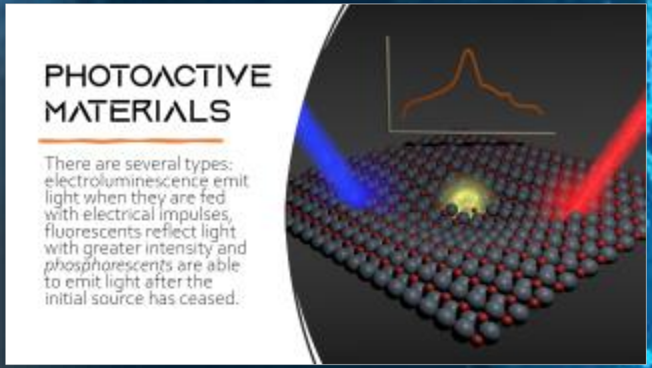
Smart materials are new generation materials which possess the ability to change their physical properties in a specific manner in response to specific stimulus input. The stimuli could be pressure, temperature, electric and magnetic fields, chemicals, hydrostatic pressure or nuclear radiation. The associated changeable physical properties could be shape, stiffness, viscosity or damping.

WHAT ARE THE TYPES OF SMART MATERIALS?

1. Piezoelectric Materials
2. Magnetorheological materials
3. Photoactive materials
4. Chromic materials
5. Shape memory materials



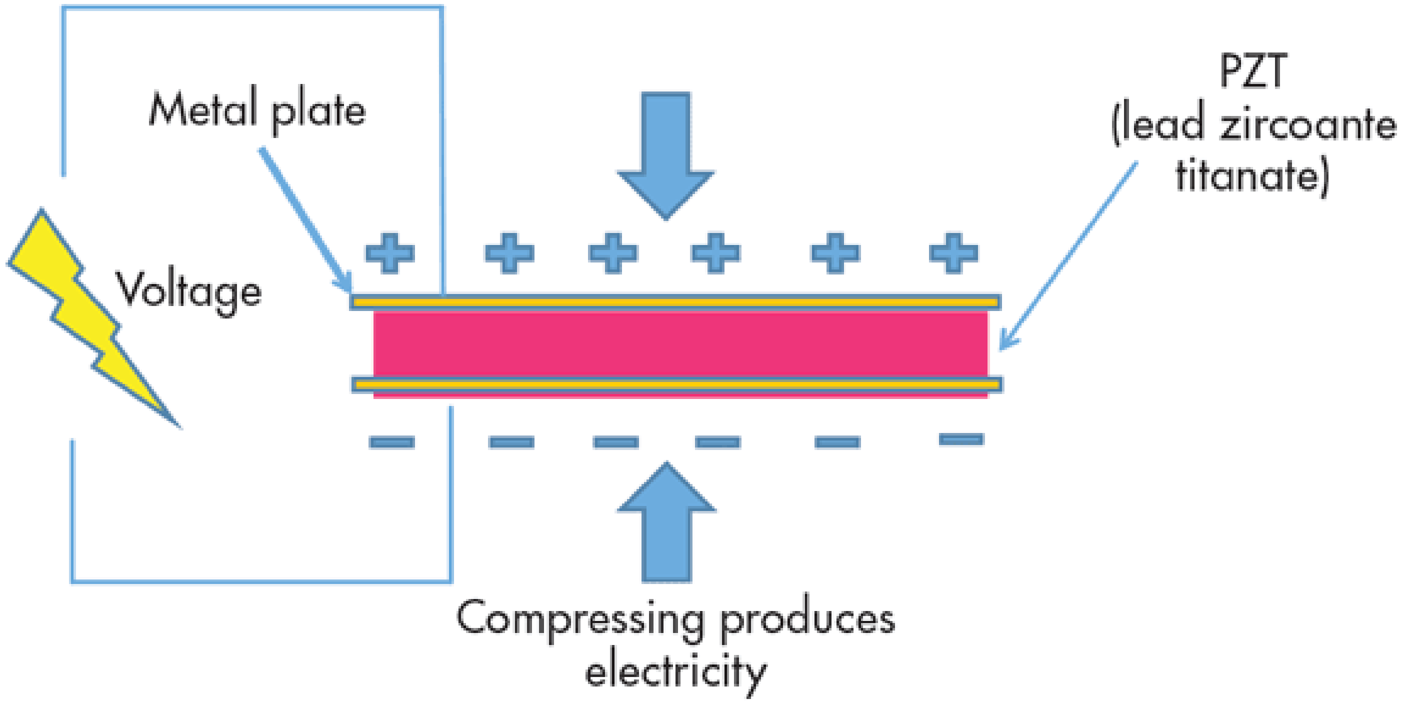




Piezoelectric Materials

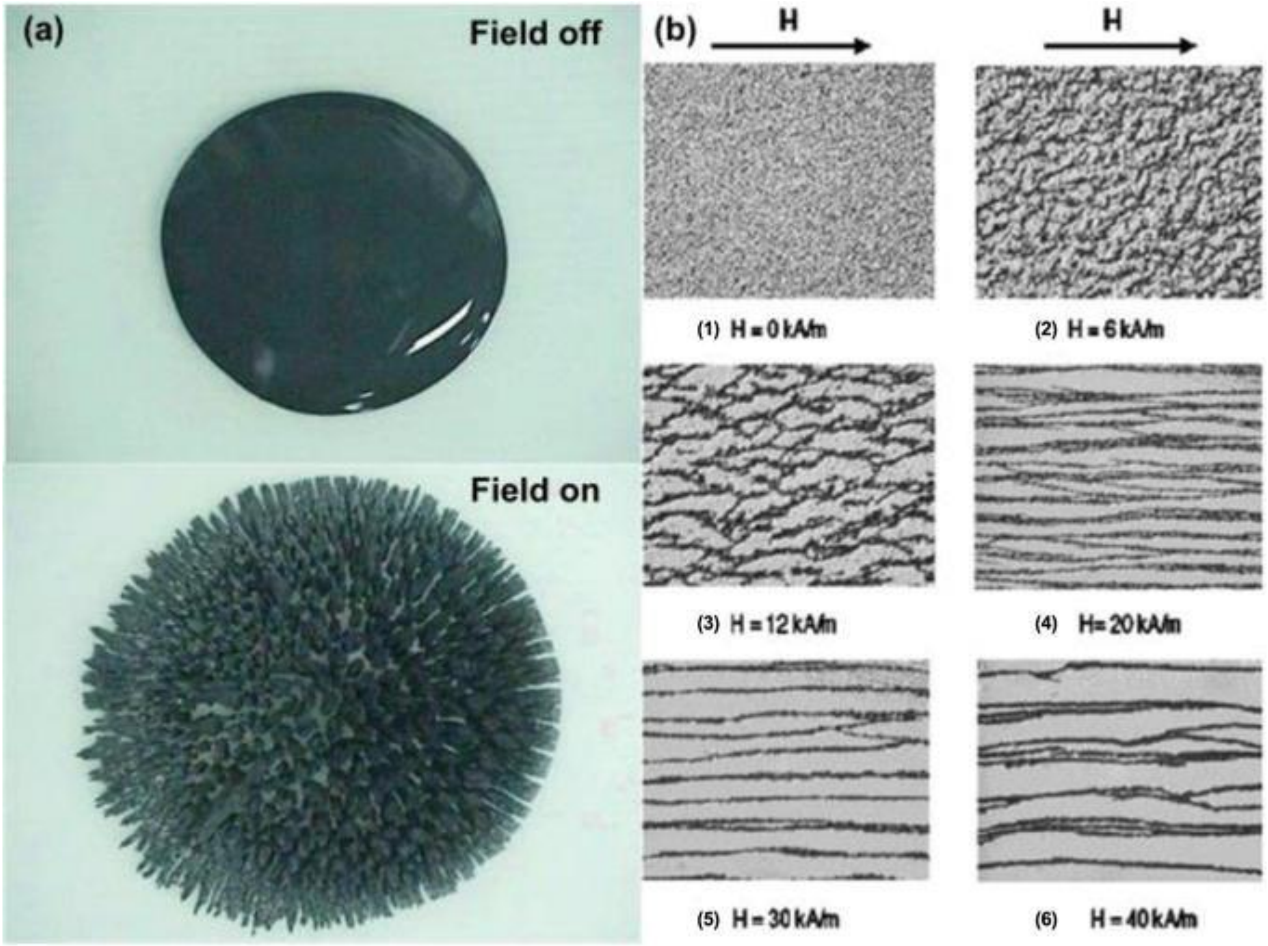
They can convert mechanical energy into electrical energy and vice versa.

For example, they change their shape in response to an electrical impulse or produce an electrical charge in response to an applied mechanical stress.



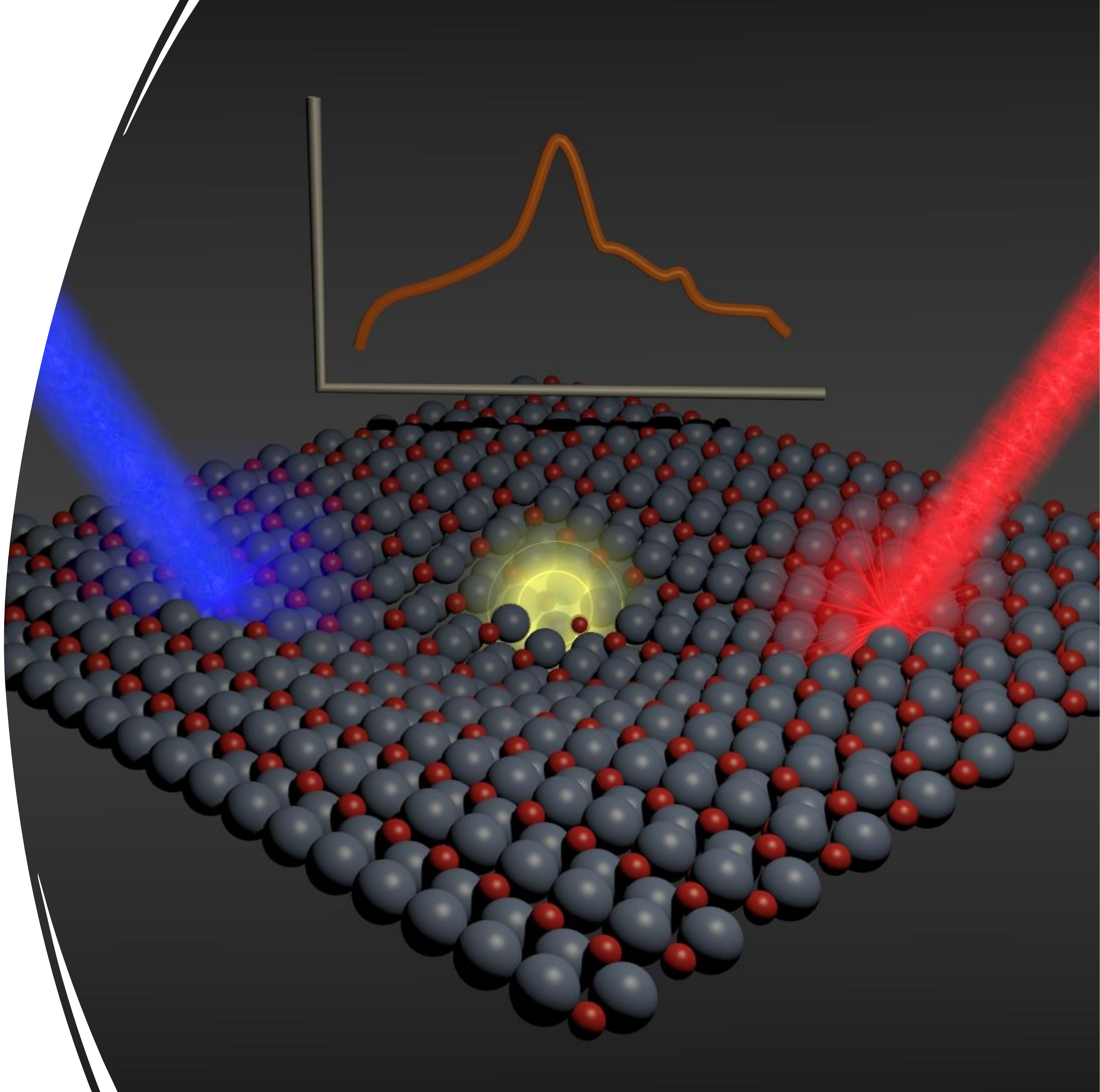
Magneto Rheological Materials

They change their properties when exposed to a magnetic field. For example, they are currently used in shock absorbers to prevent seismic vibrations in bridges or skyscrapers.



PHOTOACTIVE MATERIALS

There are several types: electroluminescence emit light when they are fed with electrical impulses, fluorescents reflect light with greater intensity and *phosphorescents* are able to emit light after the initial source has ceased.



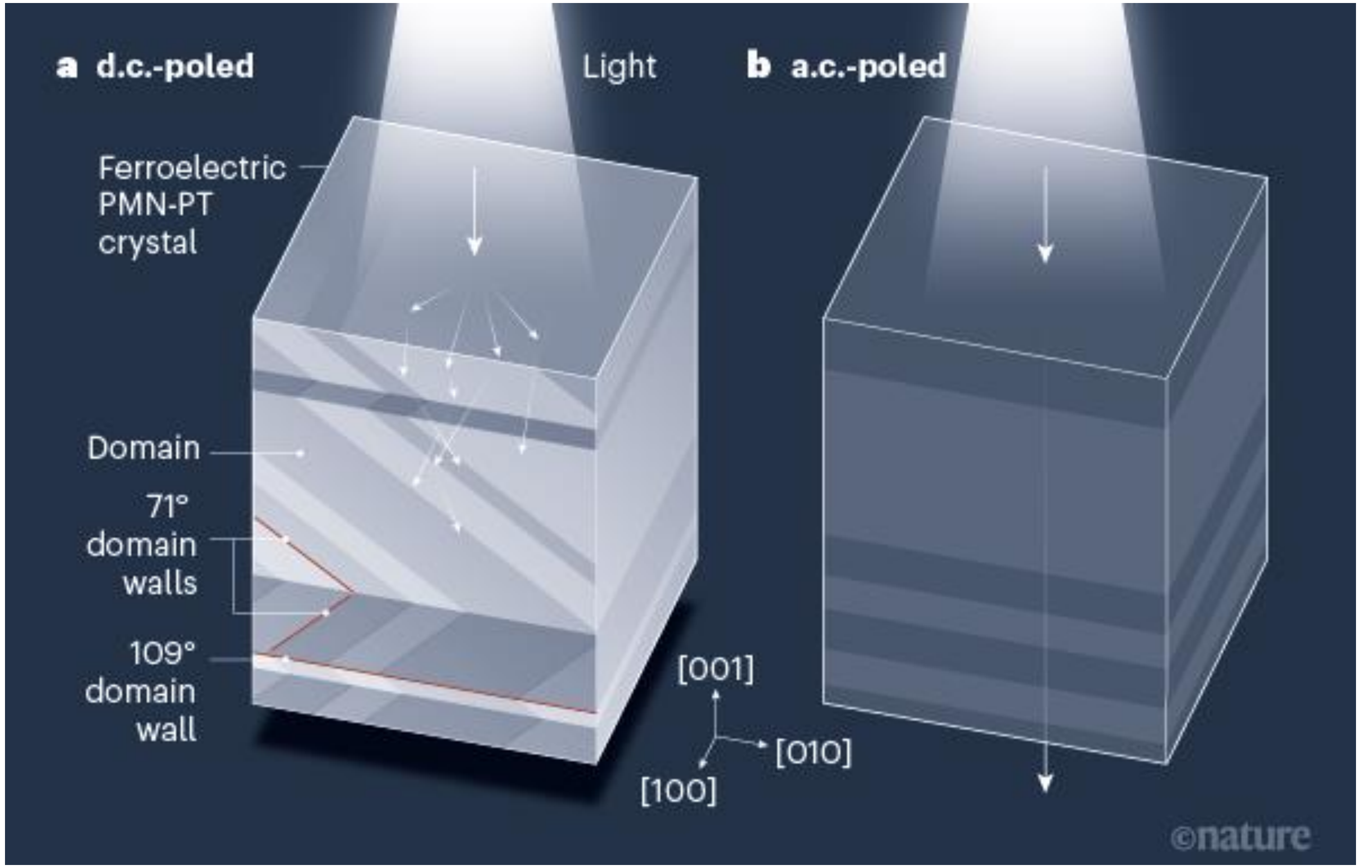
CLASSIFICATION OF SMART MATERIALS

By 51. Balraj Tavanandi

ACTIVE SMART MATERIALS

Active smart materials are those materials which possess the capacity to modify their geometric or material properties under the application of electric, thermal or magnetic fields, thereby acquiring an inherent capacity to transduce energy.

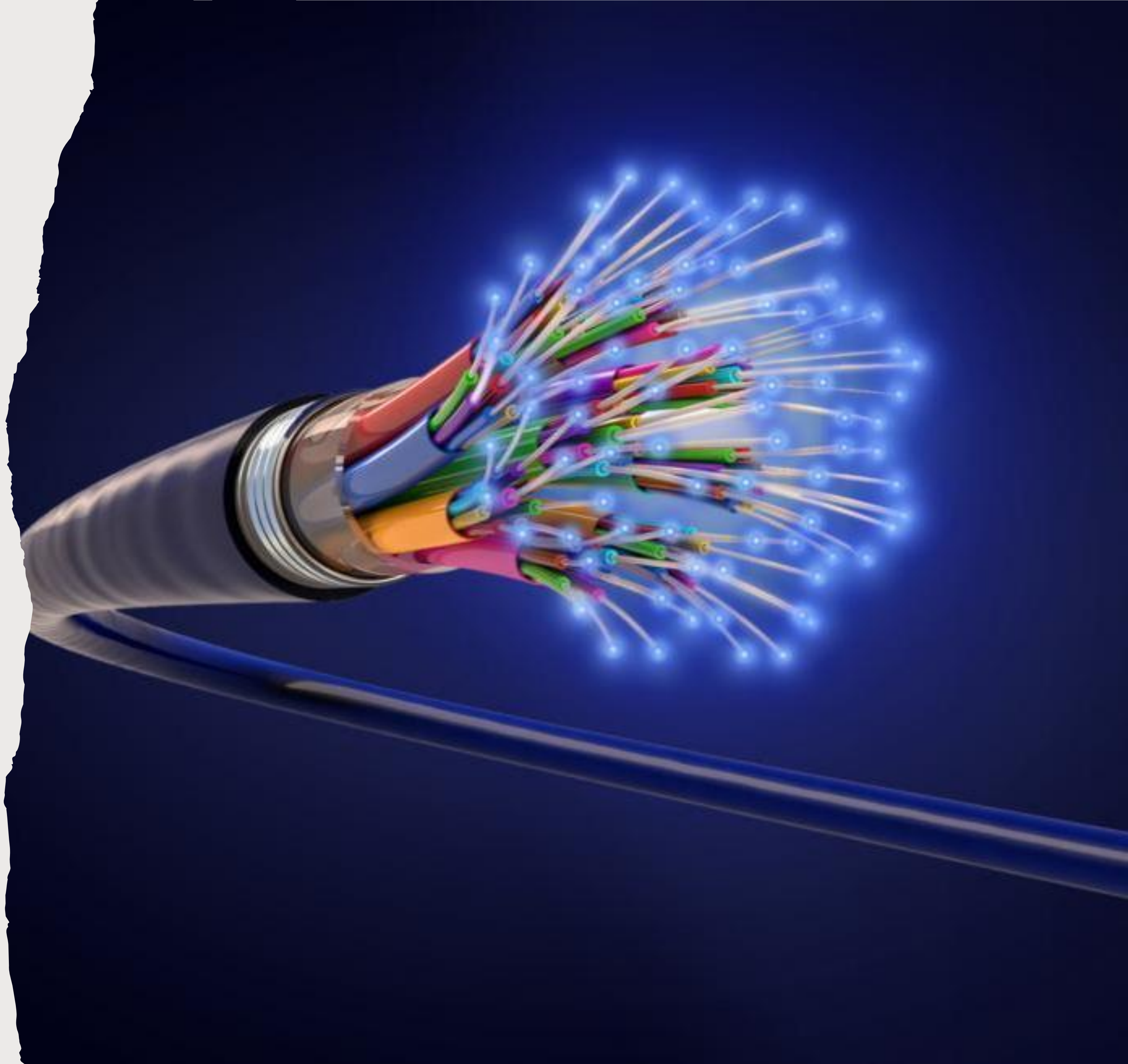
Eg : Piezoelectric materials.



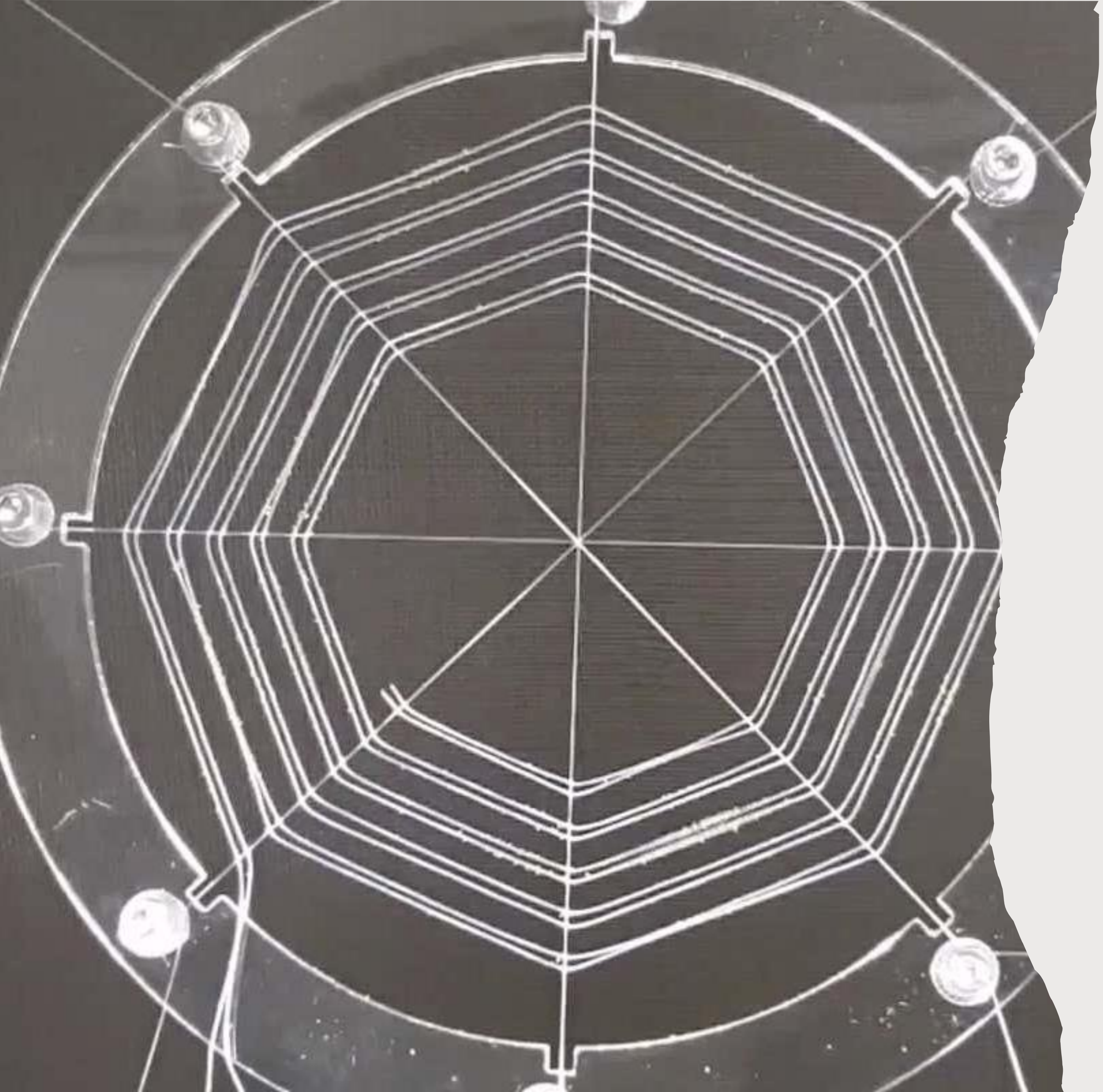
PASSIVE SMART MATERIALS

Although smart, they lack the inherent capability to transduce energy.

Fiber optic material is a good example of a passive smart material. Thus the materials used in an optic fiber can act as sensors in a wide variety of applications.



Applications of Smart Materials



1. SYNTHETIC SPIDER WEB

This material is not only five times stronger than steel, but also has great elasticity. It is mainly used in

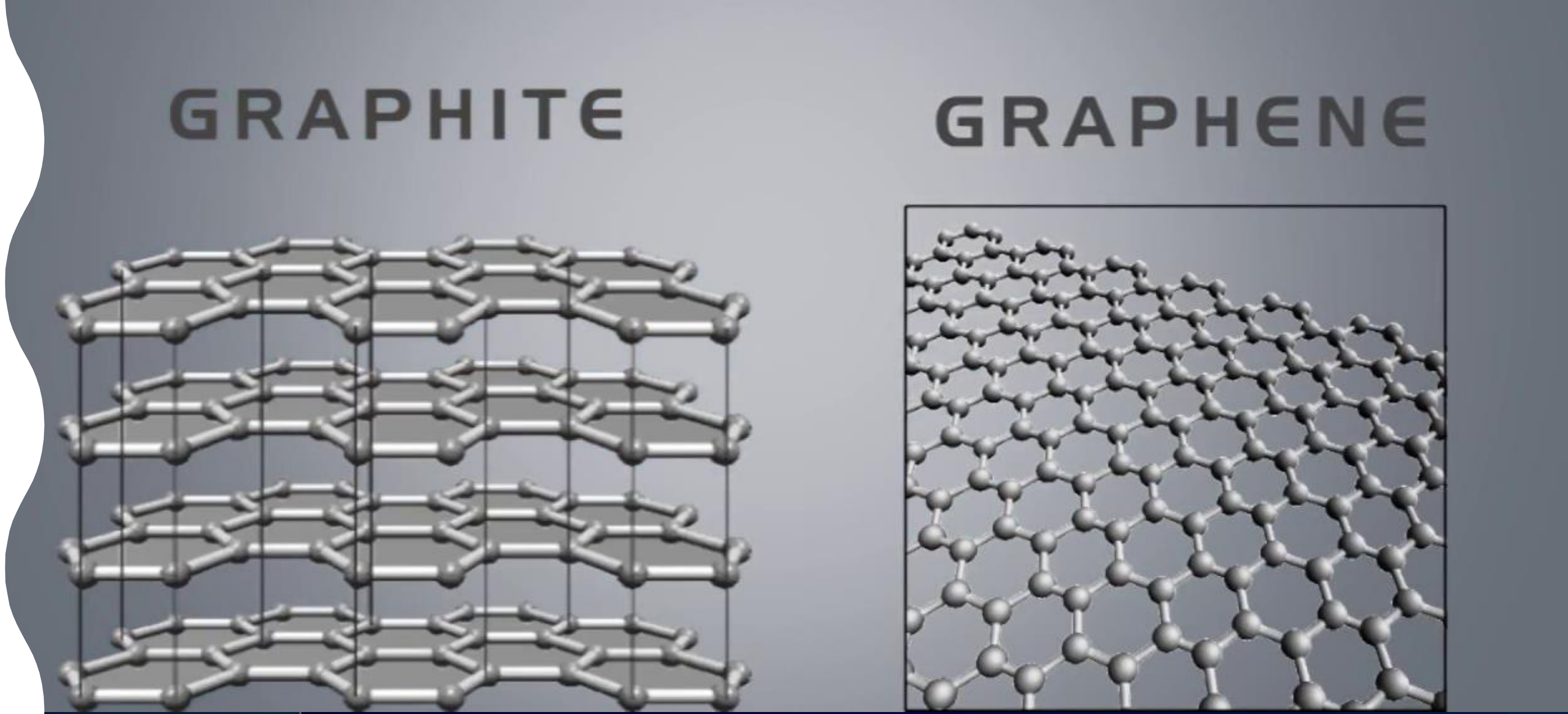
Potential uses include: bulletproof clothing, artificial skin for burns or waterproof adhesives.

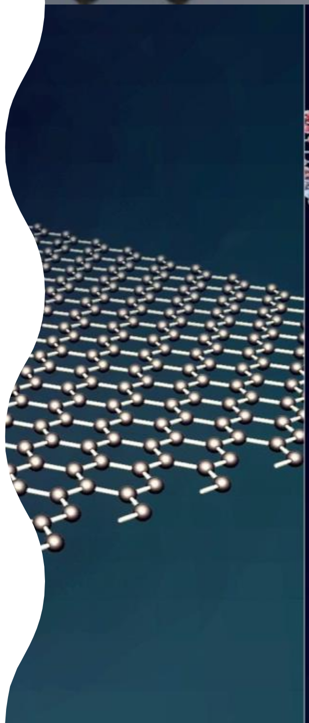
2. SHRILK

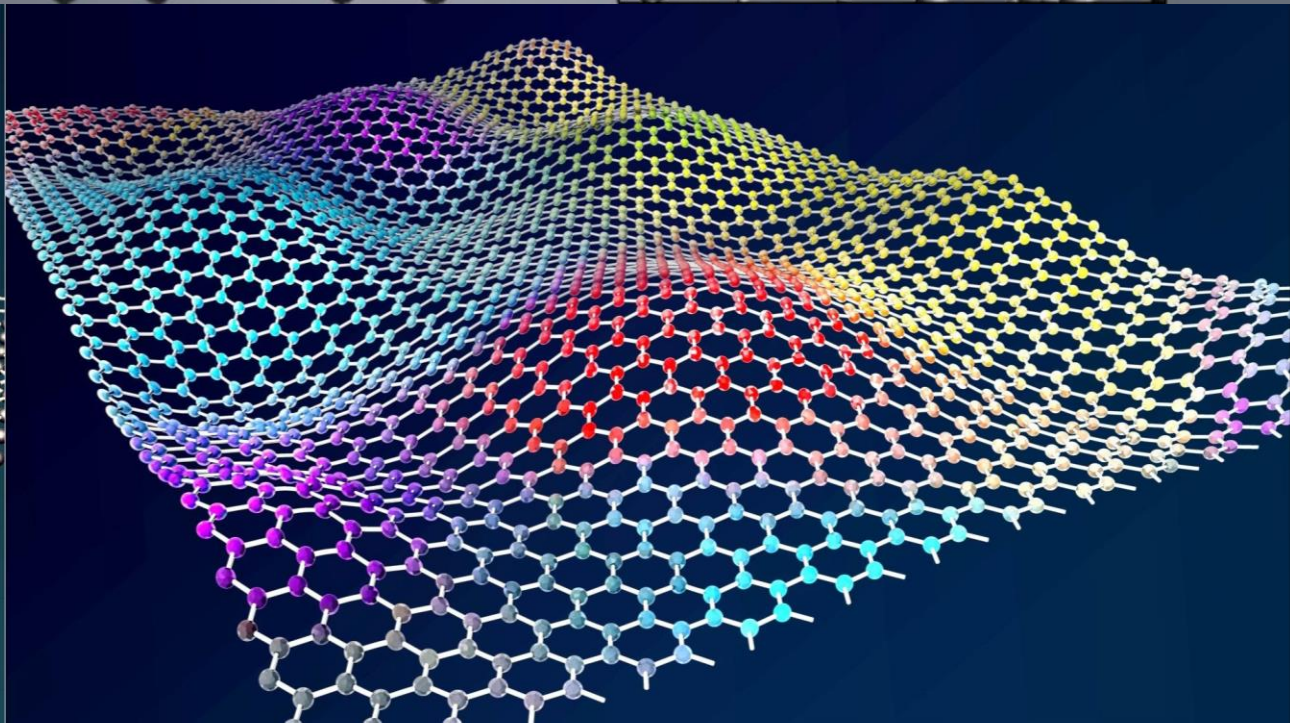
Its main component is chitin, a carbohydrate found in krill shells. It was created by researchers from Harvard University and is considered the ideal substitute for plastic — since its decomposition time is only two weeks and it also works as a stimulant for plant growth

3. GRAPHENE

Its potential uses are almost unlimited: batteries with more autonomy, cheaper photovoltaic solar cells faster computers, flexible electronic devices, more resistant buildings, bionic limbs, etc. All this is possible thanks to their multiple properties.

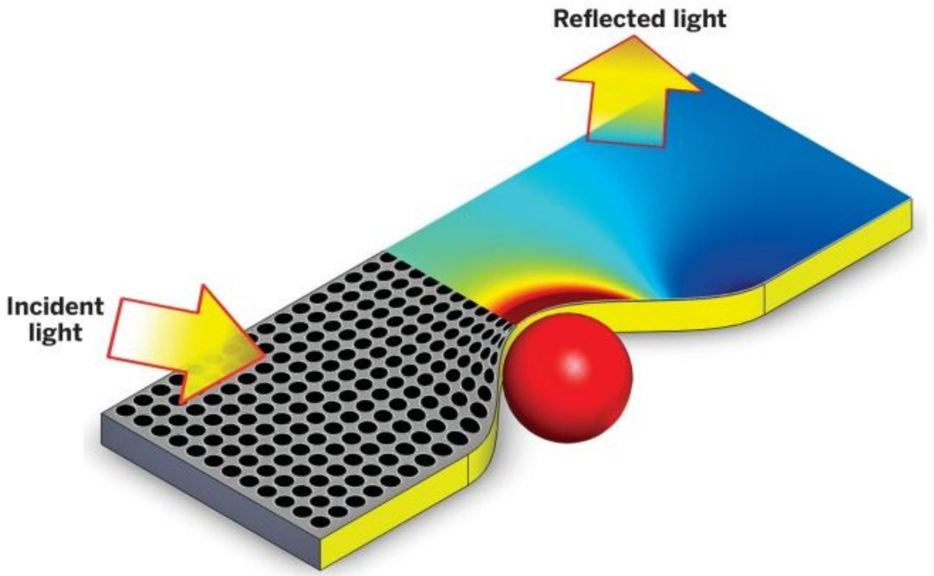


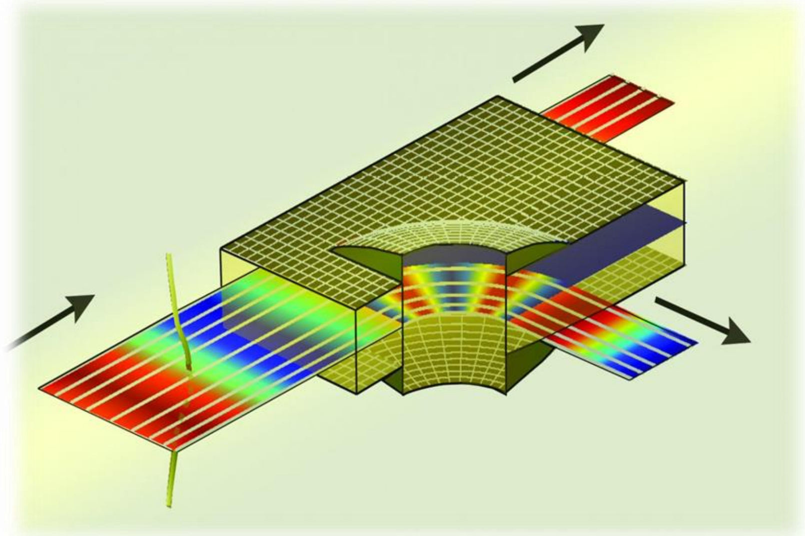




4. METAMATERIALS

They are manufactured in the laboratory with unusual physical properties not found in nature and are the subject of research in fields such as the military, optics or telephony. They can, for example, bend electromagnetic waves of light creating negative refractive indices.





5.XPL

It is a silicone-based polymer that adheres to the dermis like a second skin. Created by scientists at the Massachusetts Institute of Technology (MIT), it replicates the appearance of young, healthy skin by rejuvenating the look of the wearer.

CHROMIC MATERIALS – 71. Pranav Walvekar

WHAT ARE CHROMIC MATERIALS?

Chromic materials are the materials, which radiate colour/erase colour or change in colour due to induction of an external stimulus. These materials can change its colour due to change of intensity of different stimuli.

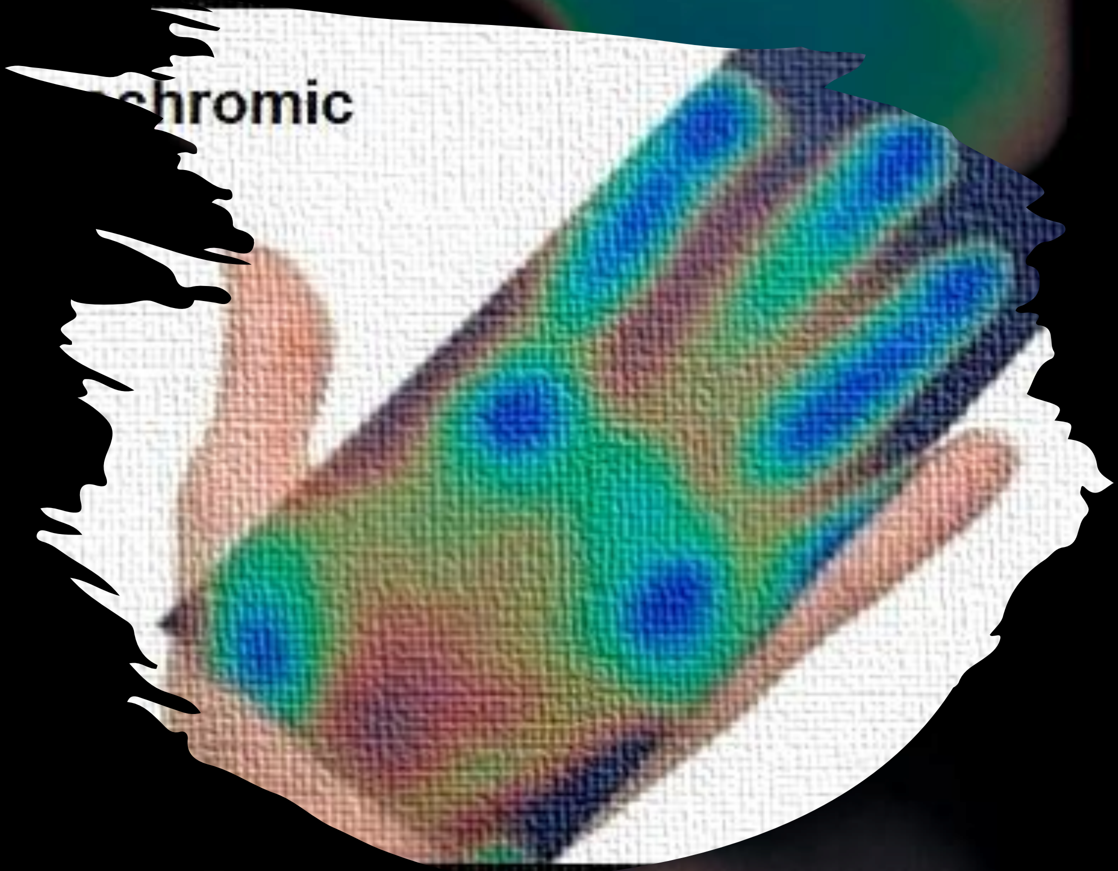
Types of Chromic Materials

PHOTOCHROMIC MATERIALS

In this kind of chromism the colour change is due to change in light or UV radiation. These chromic materials interact with UV, visible and IR rays and affects variety of reversible effects. The change in colour on external rays/radiation stimuli can happen in different ways.

THERMOCHROMIC MATERIALS

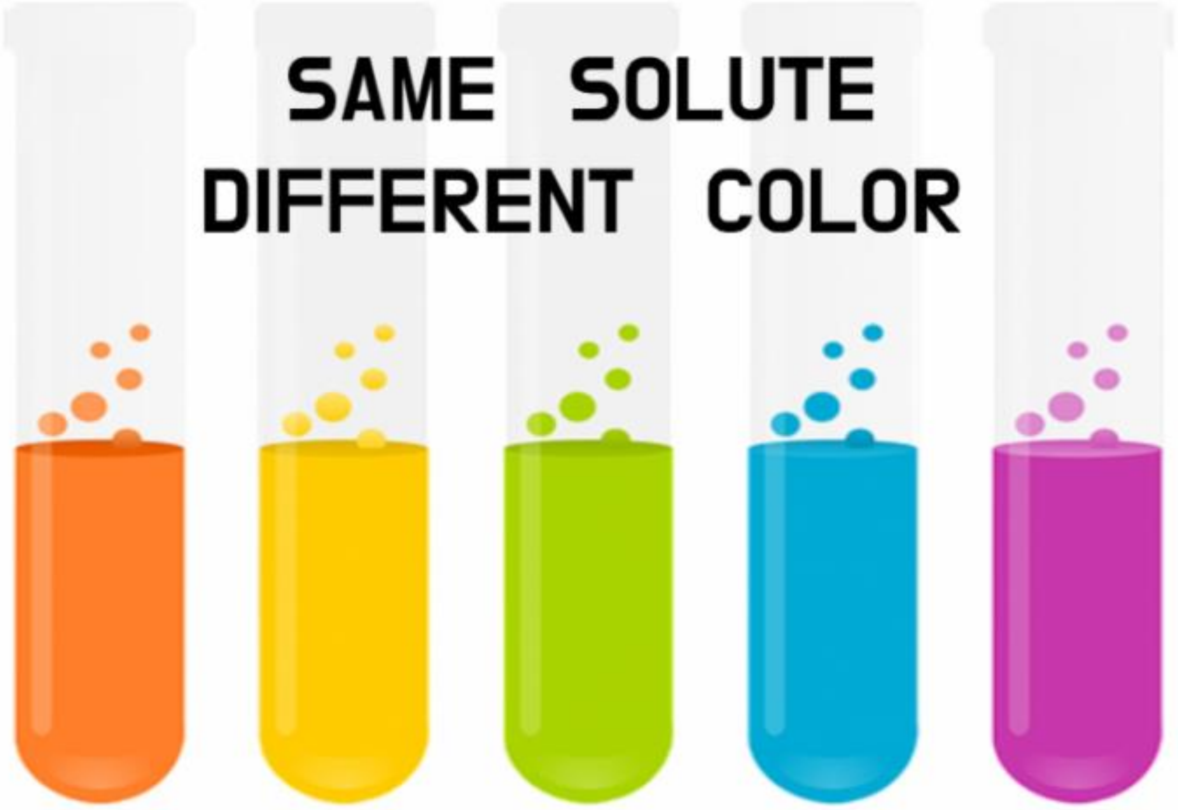
Thermochromic materials change reversibly their color by a temperature change. Color transition is due to a change in crystalline phase and structure. Thermochromic materials are generally organic leuco-dye mixtures, composed by the color former, the color developer, and the solvent.



SOLVATOCHROMIC MATERIALS

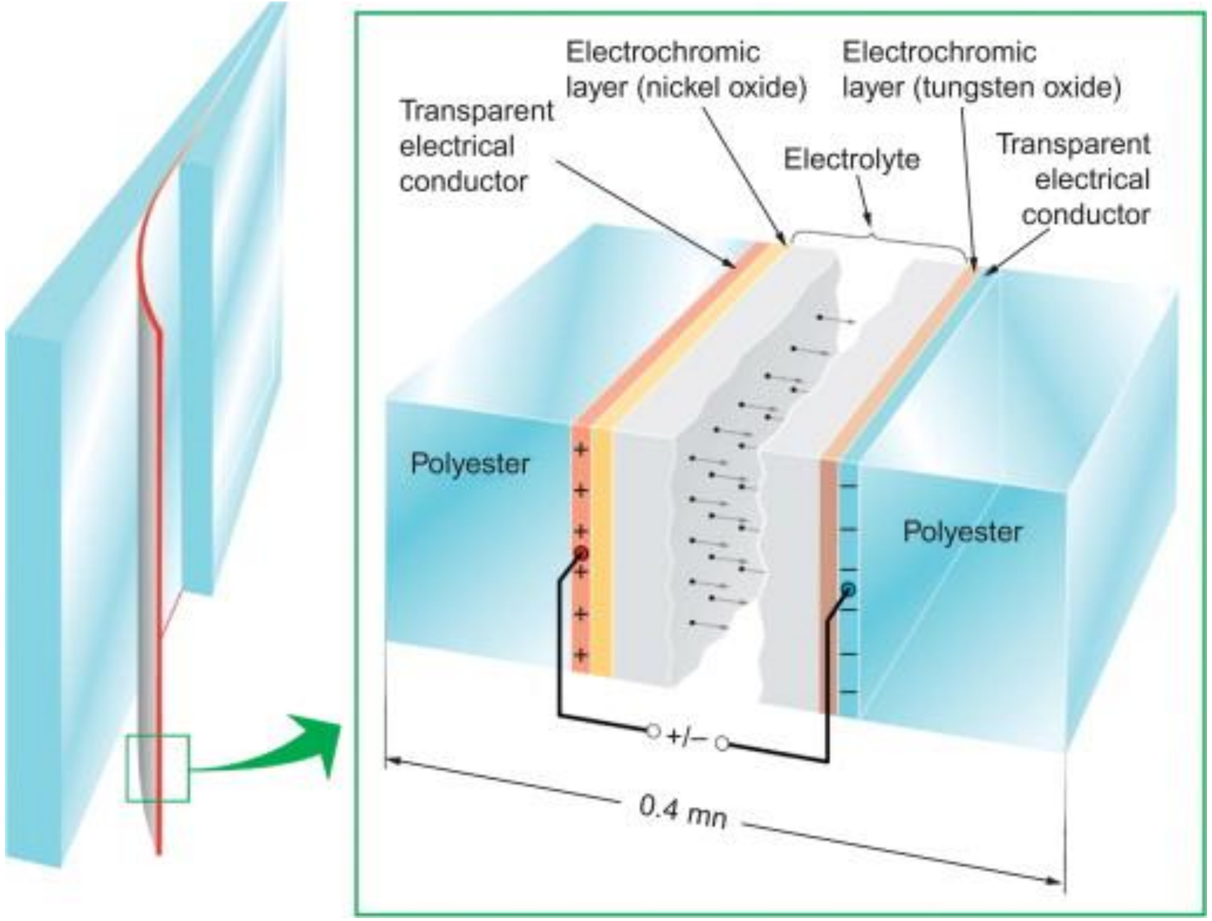
They are those chromic materials that change colors when wetted with water and changes back to original color when dried. They are also known as hydro-chromic or aqua-chromic.

These materials are normally used for designing prints on swimsuits, babies nappies, umbrellas and rain-wears. Hydro-chromic materials have their applications as print inks.



ELECTROCHROMIC MATERIALS

The materials that change colour on application on voltage are known as electro-chrome. The electro-chromism is induced by gain and loss of electrons i.e usually due to oxidation and reduction process.



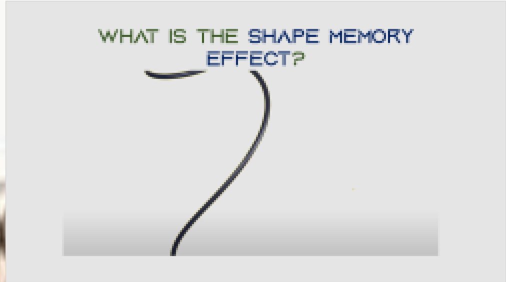
SHAPE MEMORY ALLOYS

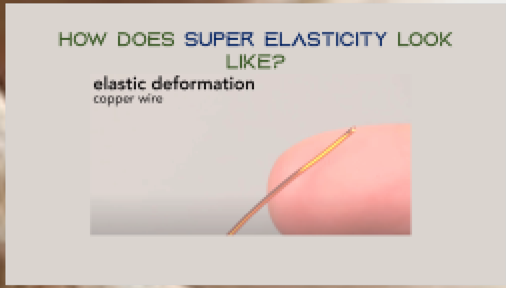
By 54. Krishnaraj Thadesar

Borderline Magic

2 SPECIAL EFFECTS THAT MAKE IT SO MAGICAL

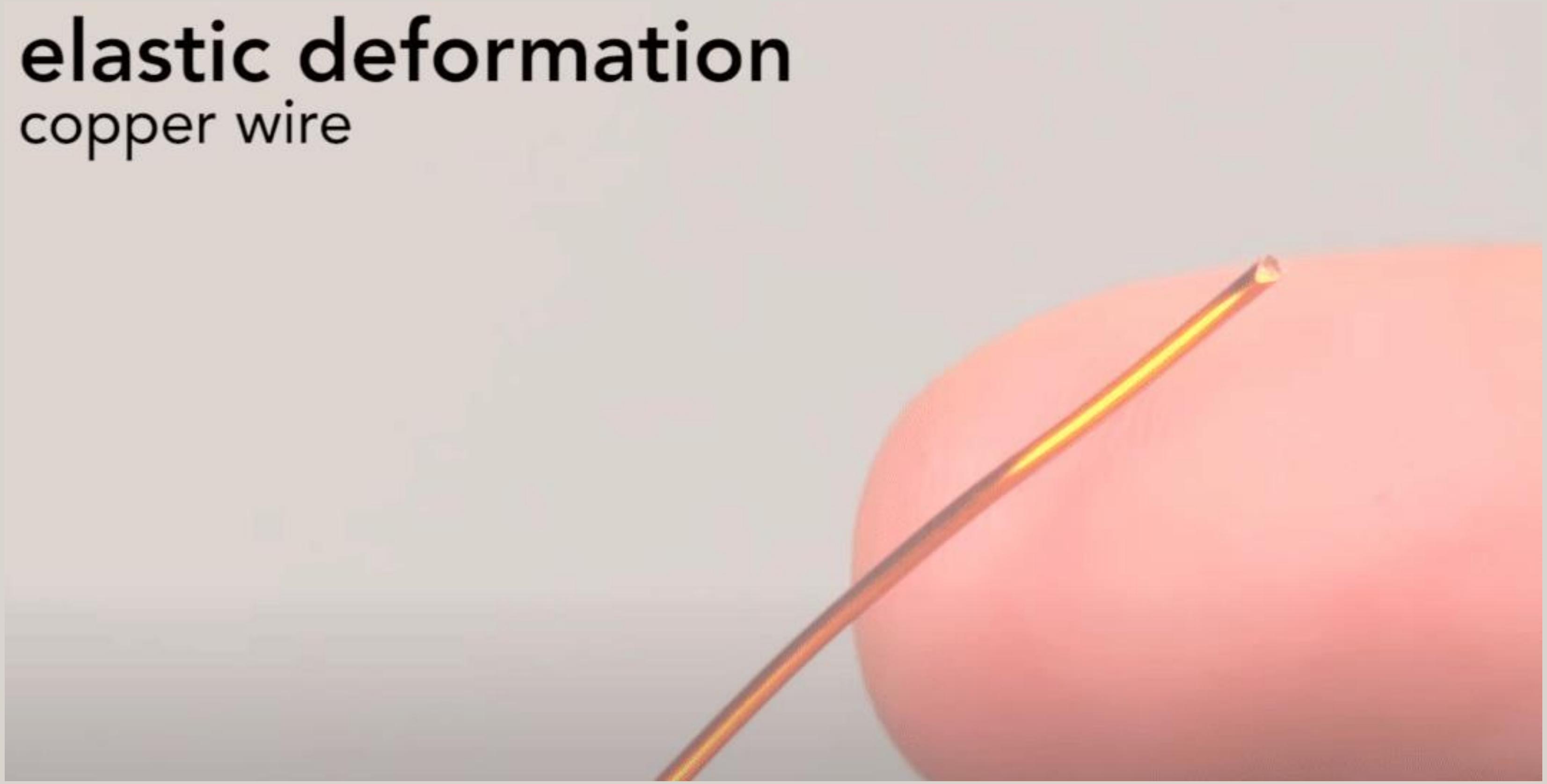
1. Shape Memory Effect
2. Super Elasticity



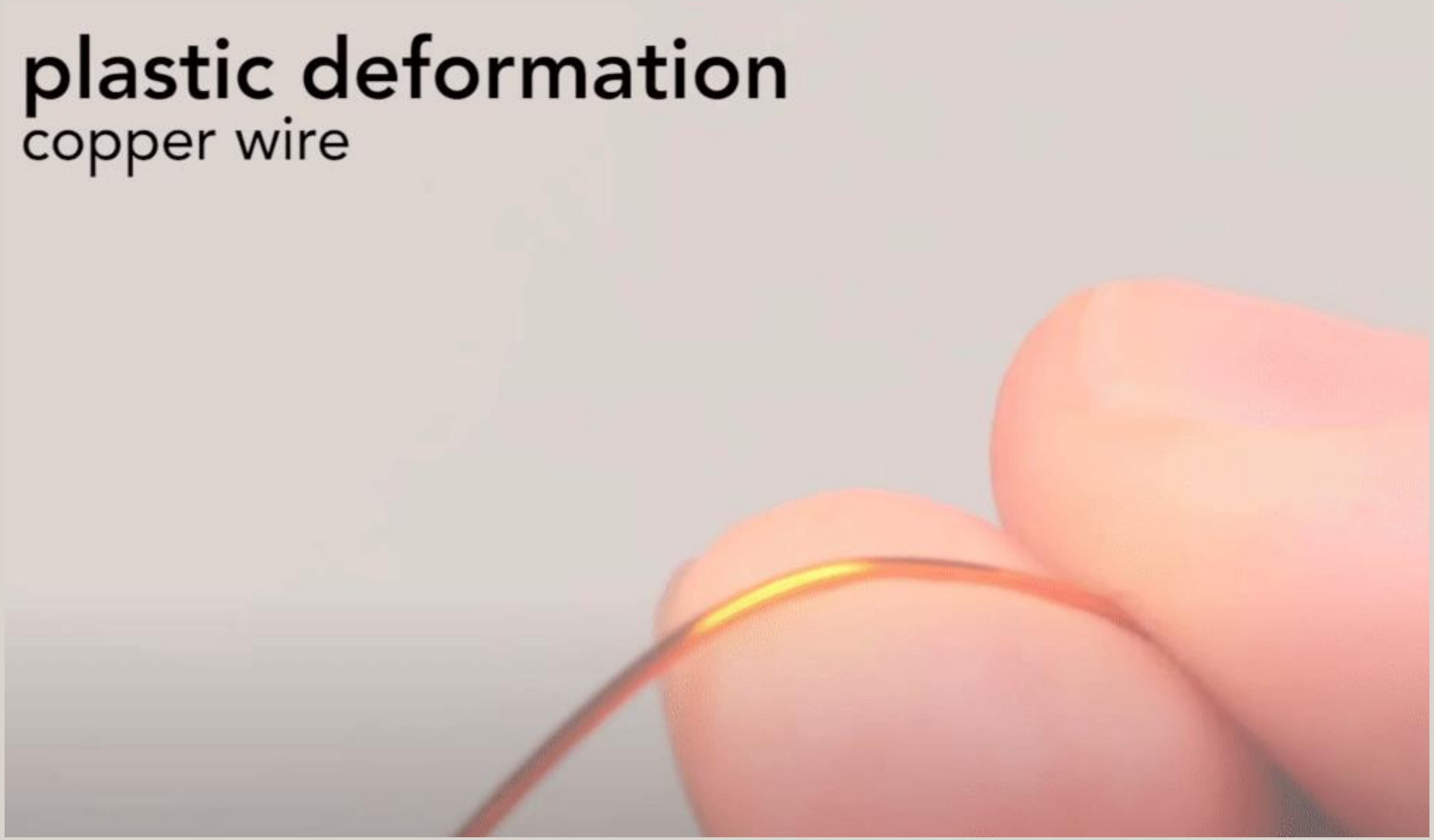


WHAT IS THE SHAPE MEMORY EFFECT?

HOW DOES SUPER ELASTICITY LOOK LIKE?

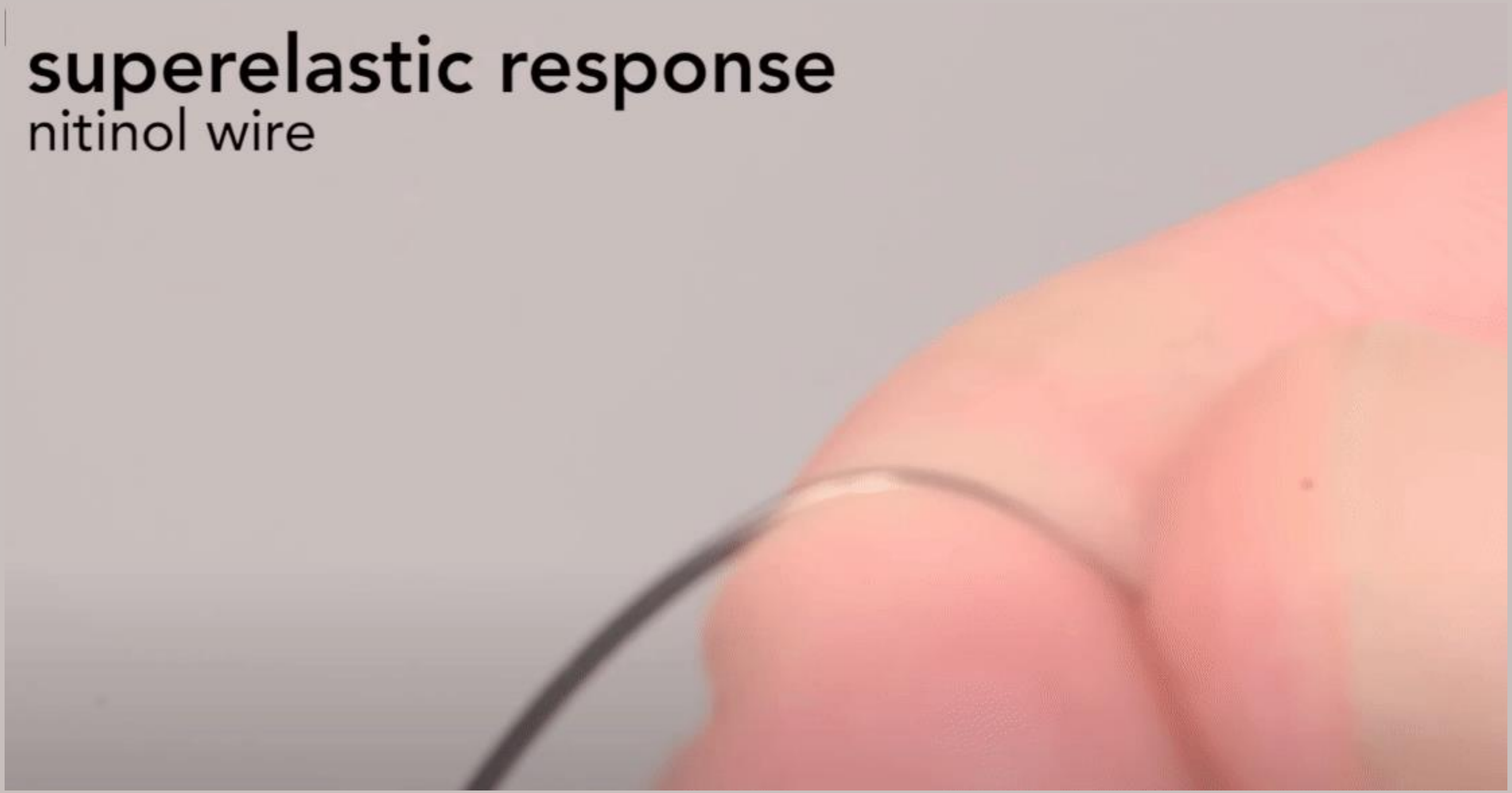


THIS IS THE USUAL PLASTIC DEFORMATION OF COPPER THAT WE ALL KNOW AND SEE



THIS IS HOW NITINOL SHOWS THE USUAL ELASTIC DEFORMATION

AND THIS IS HOW THE SUPER ELASTIC RESPONSE LOOKS LIKE FOR NITINOL



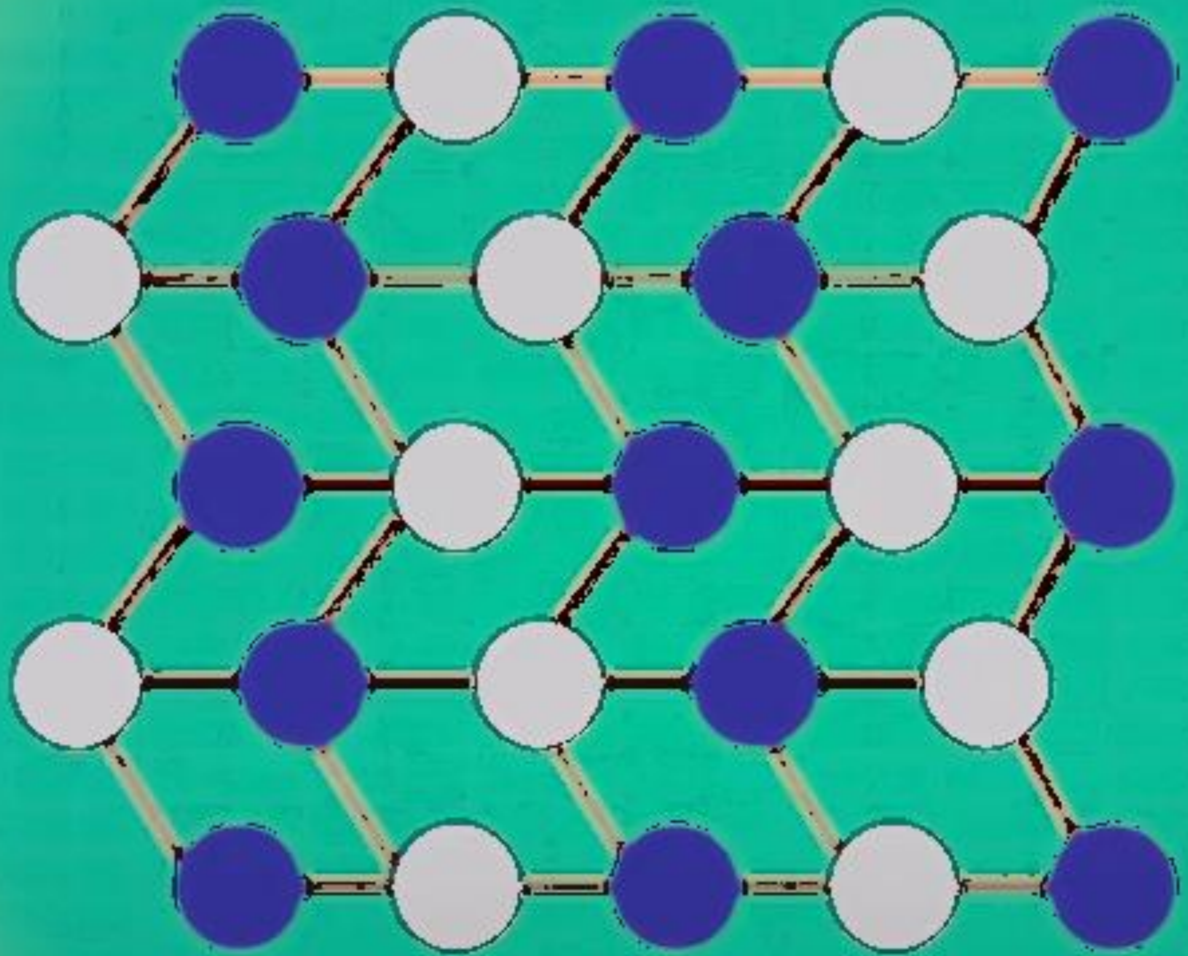
What is that material that we saw?

Nitinol - Nickel Titanium Naval Ordnance Lab

William J. Buehler along with Frederick Wang, discovered its properties during research at the Naval Ordnance Laboratory in 1959.

Nickel titanium, also known as Nitinol, is a metal alloy of nickel and titanium, where the two elements are present in roughly equal atomic percentages.

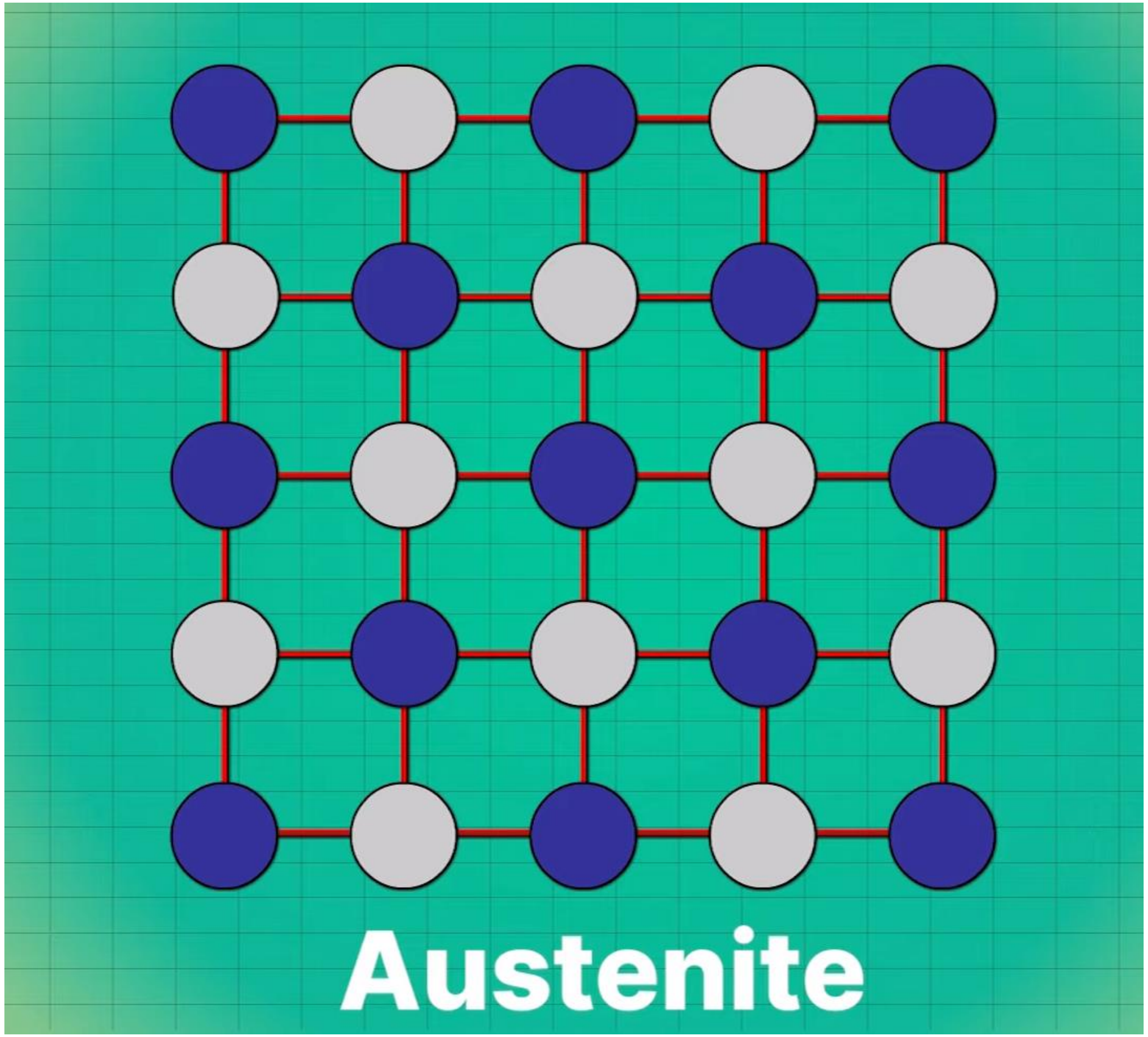
Different alloys are named according to the weight percentage of nickel; e.g., Nitinol 55 and Nitinol 60. It exhibits the shape memory effect and superelasticity at different temperatures.



SO HOW AND WHY DOES IT WORK?

It has actually a rather simple explanation using the basic concepts of crystal structures that we have already learnt.

Nickel and Titanium form Austenite at High temperatures

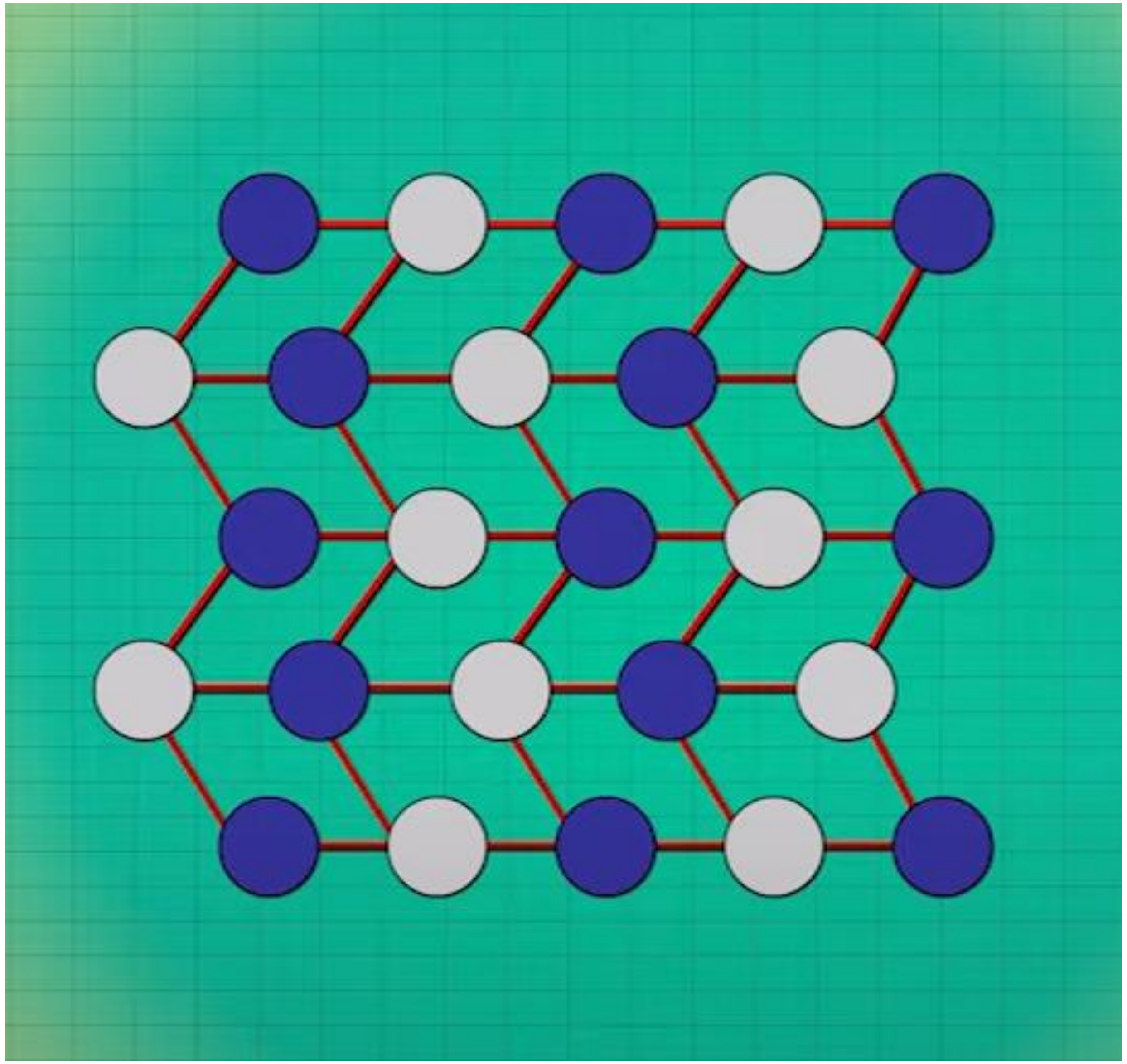


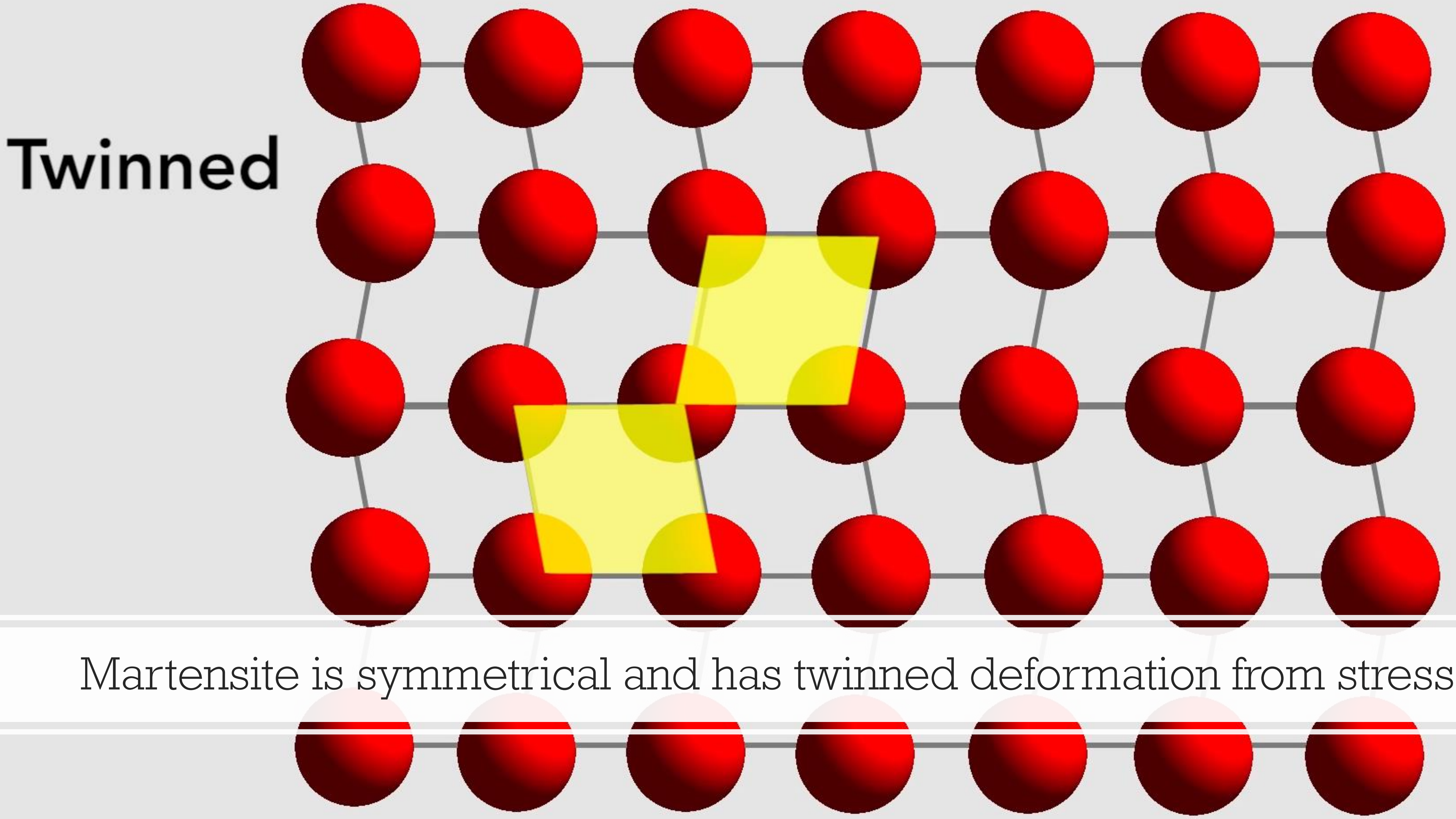
When we deform it, or when temperature is reduced, it changes into Martensite

Martensite is not that different

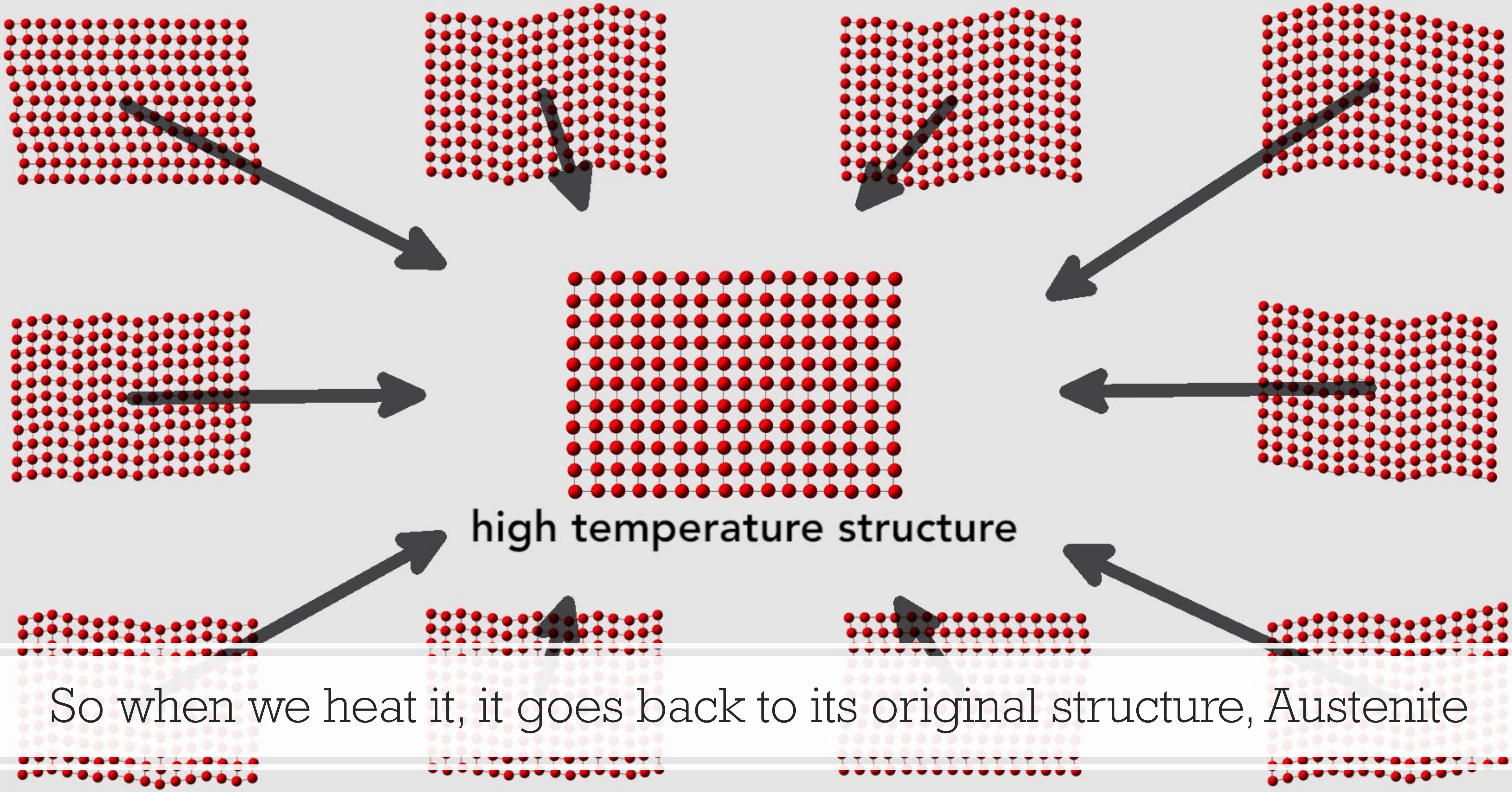
So structure doesn’t really change that much

So if you made a spring when it was hot, it will stay like a spring when it is cold



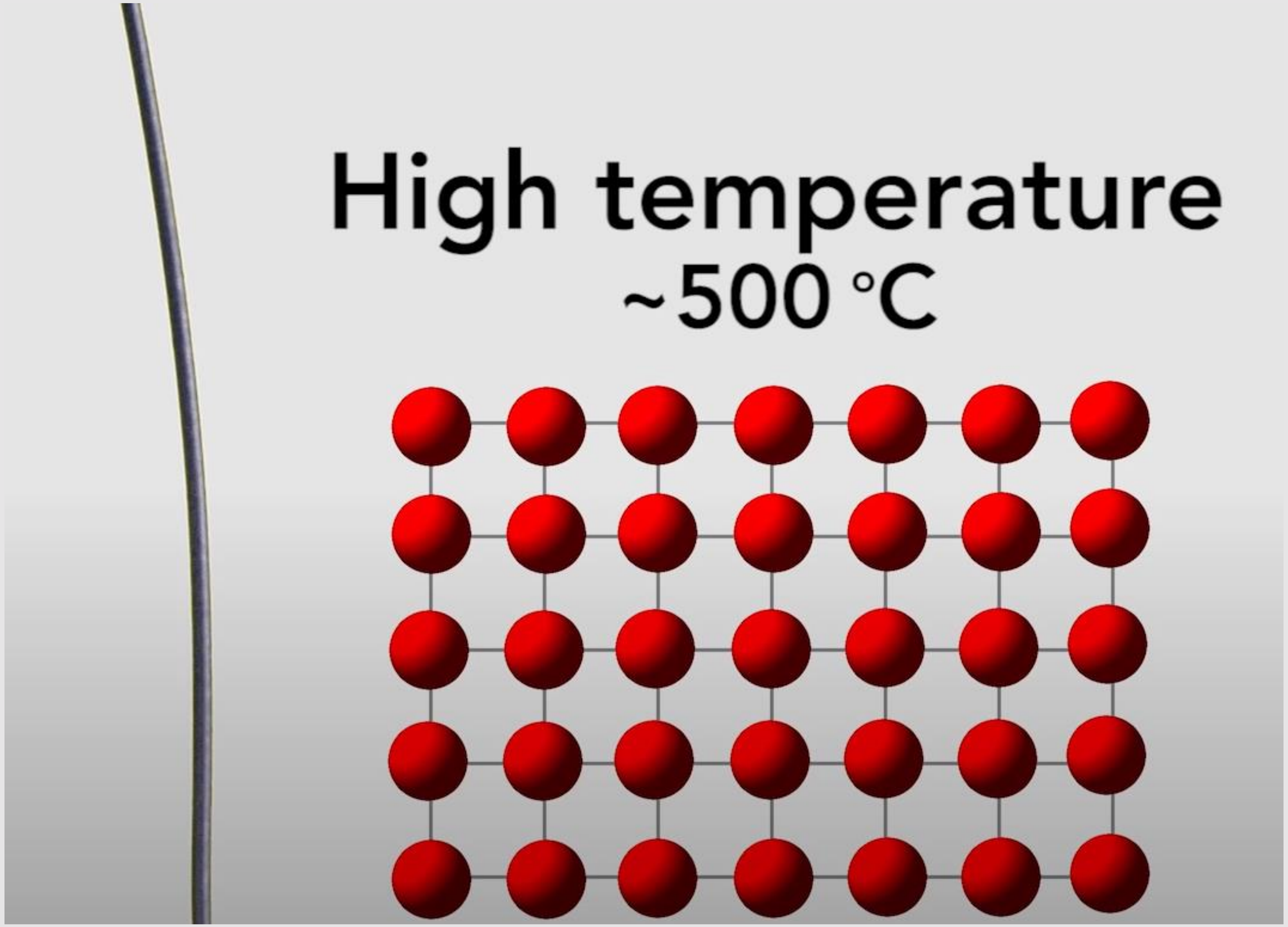


Martensite is symmetrical and has twinned deformation from stress

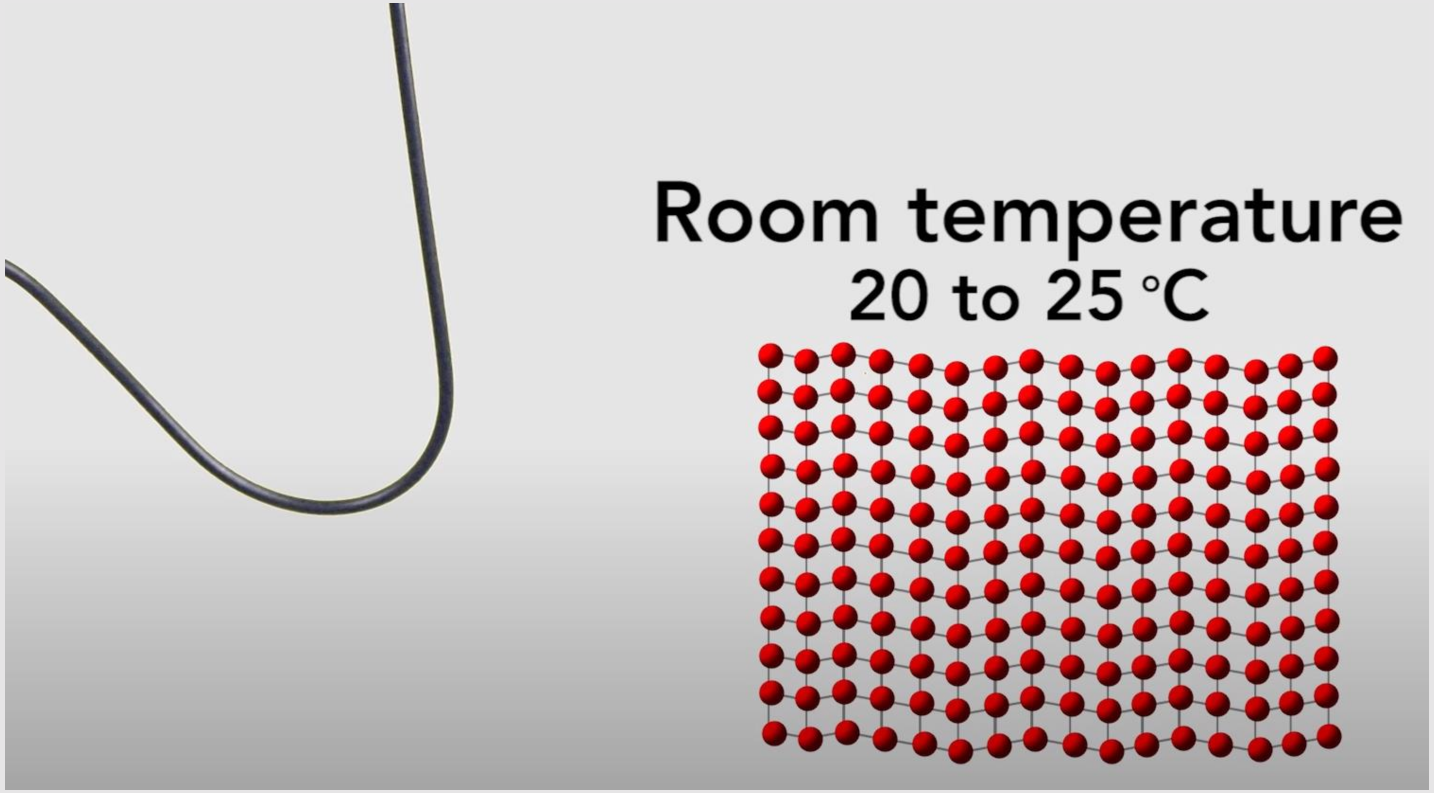


So when we heat it, it goes back to its original structure, Austenite

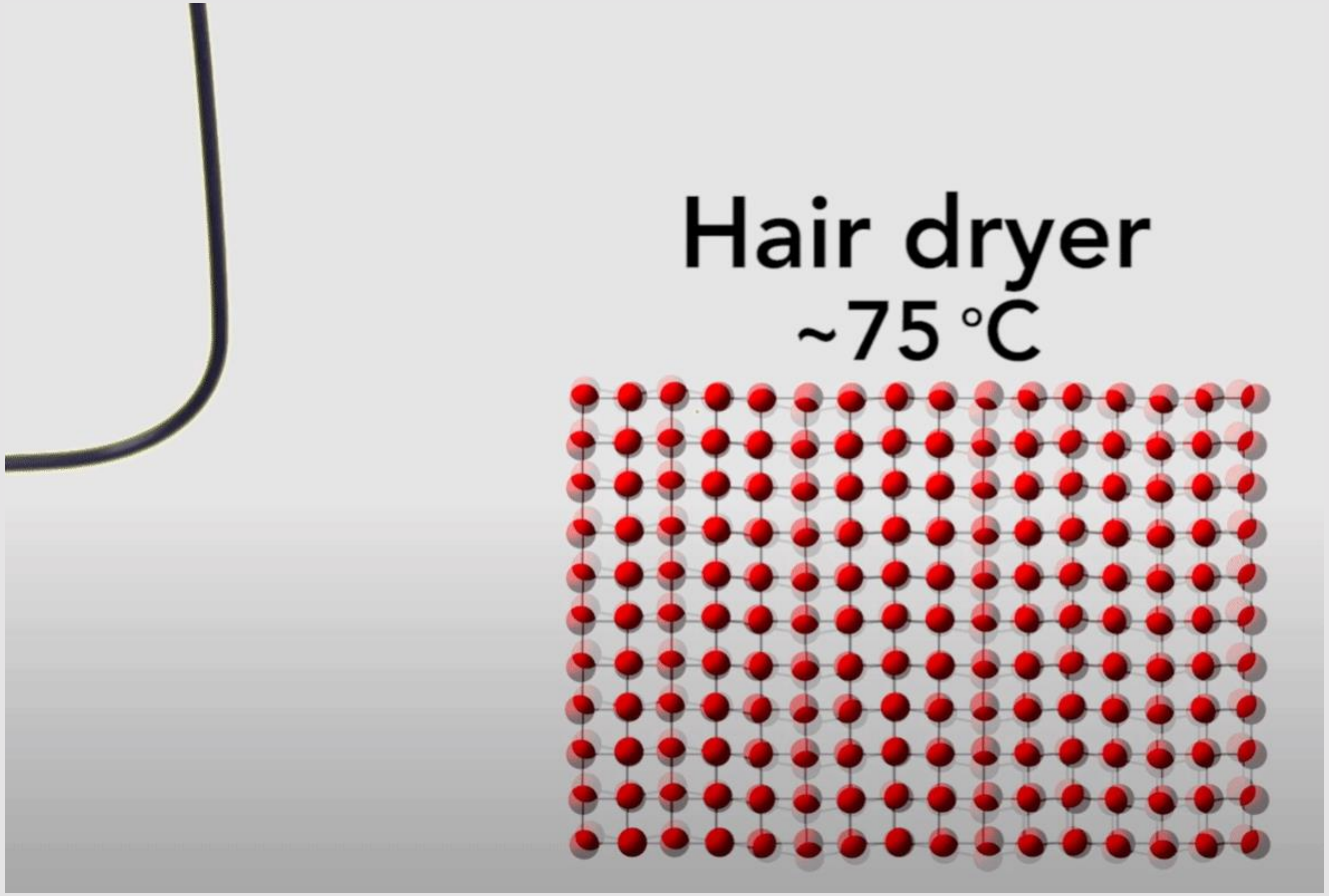
Make a straight nitinol wire at 500 C

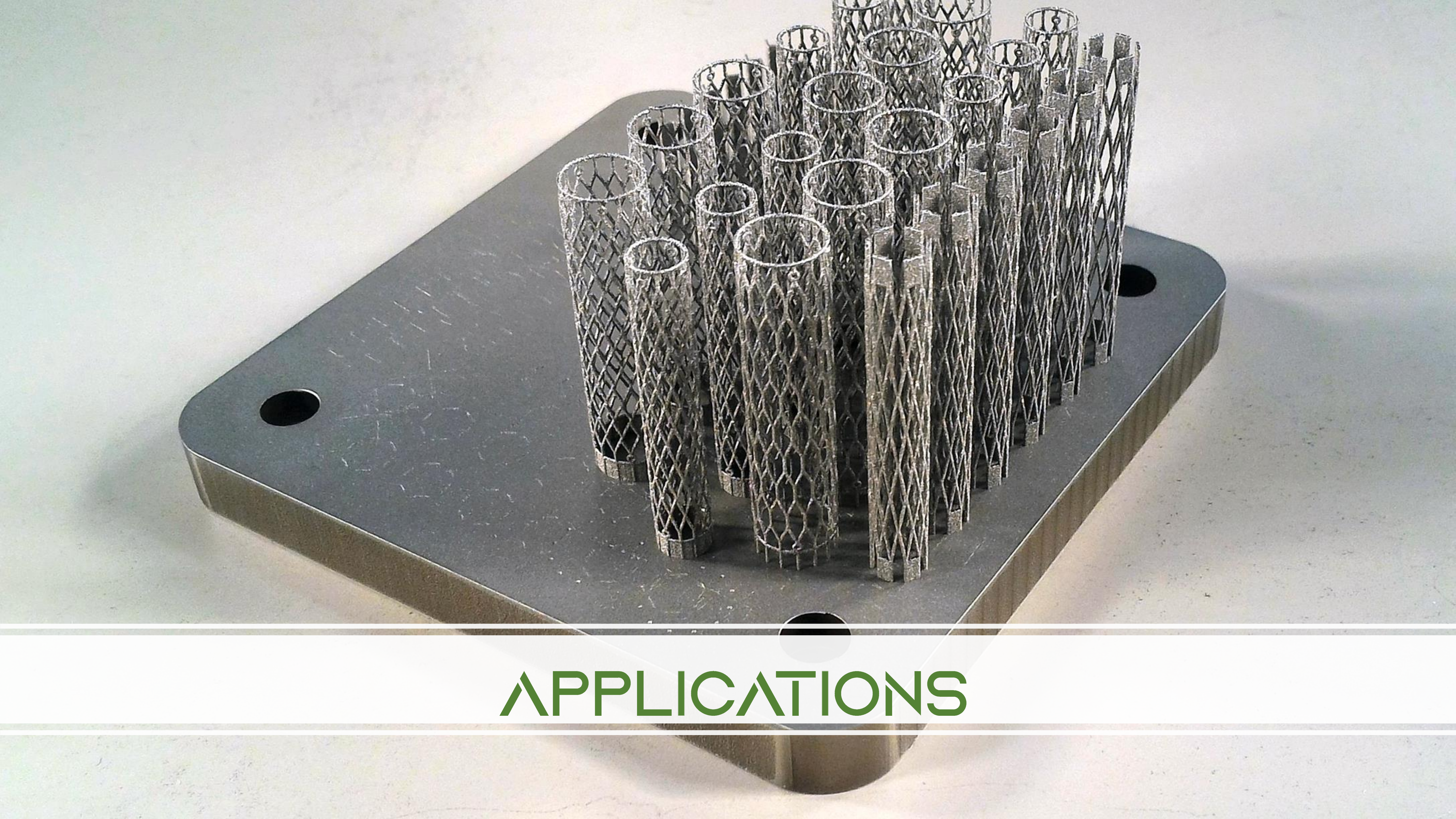


Deform it at Room temperature



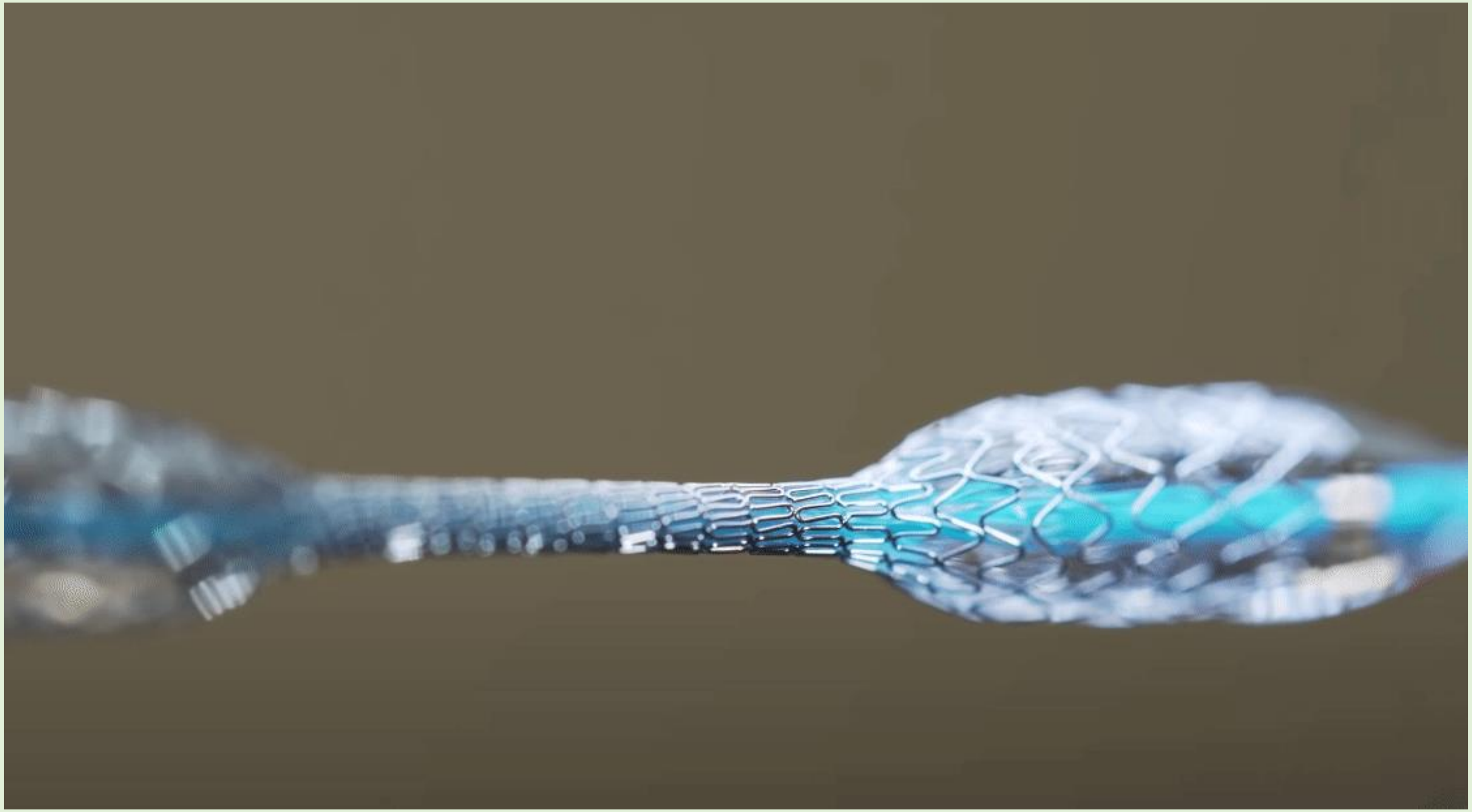
HEAT IT TO GET BACK THE ORIGINAL STRUCTURE!





APPLICATIONS

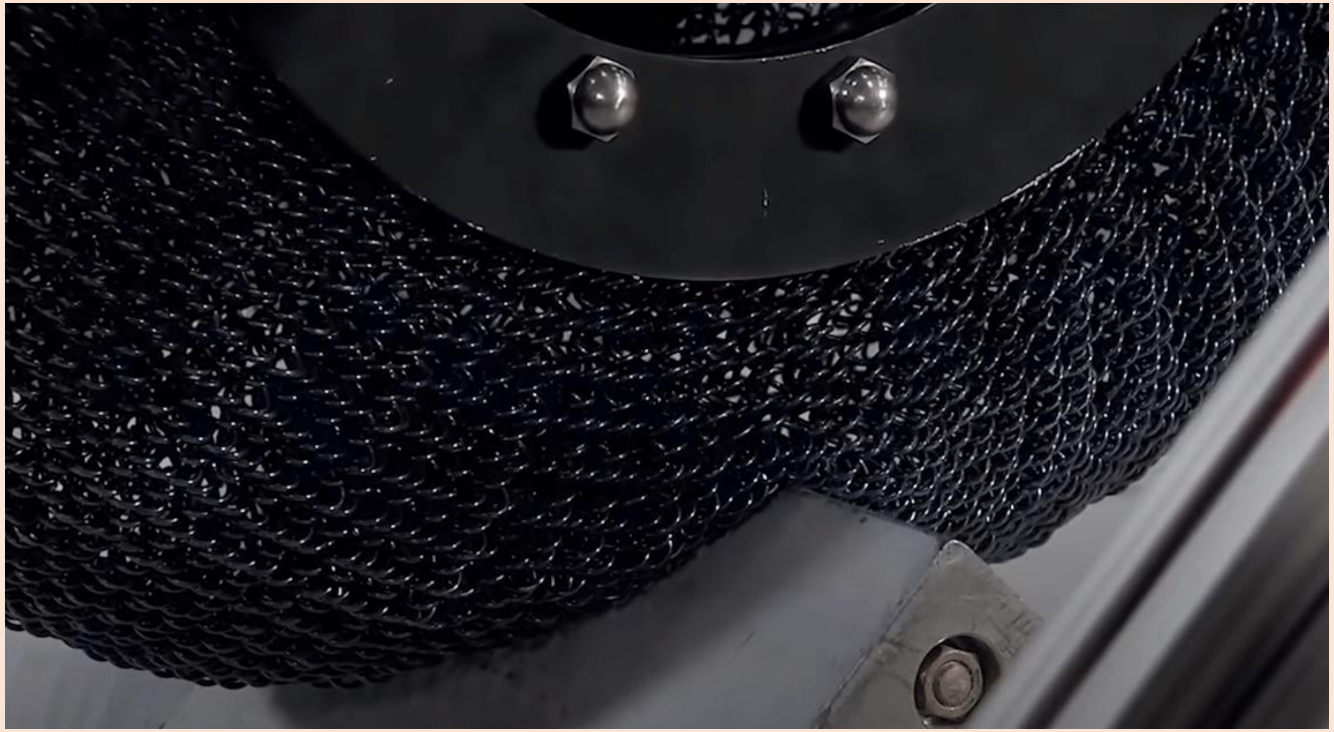
Stents in Endovascular Surgeries



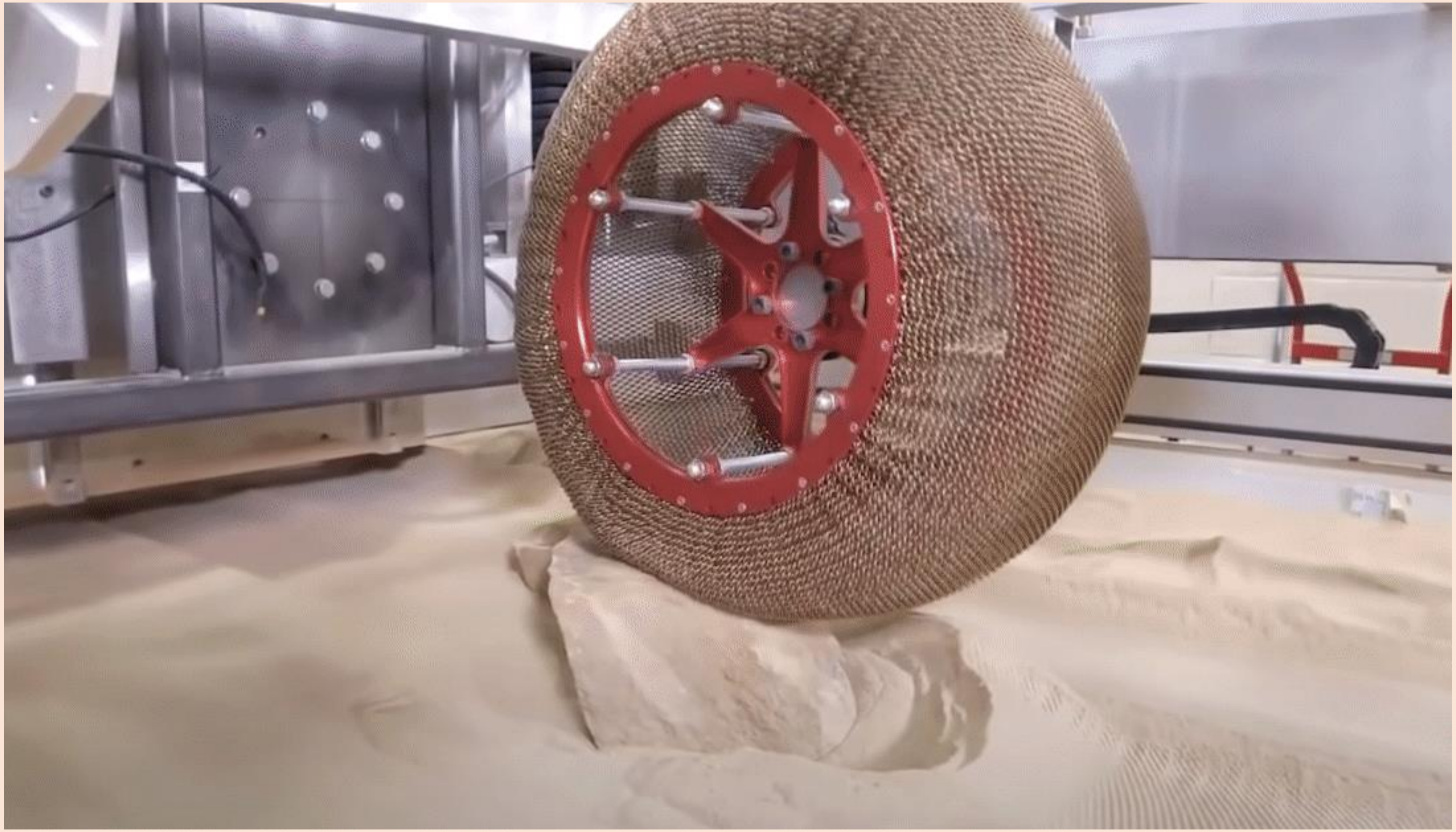
Other Biological Uses

- Dentistry, especially in orthodontics for wires and brackets that connect the teeth. "Sure Smile" dental braces are an example of its application in orthodontics.
- Endodontics, mainly during root canals for cleaning and shaping root canals.
- In colorectal surgery, the material is used in various devices for reconnecting the intestine after a pathology is removed.
- Stents.
- Orthopedic implants.
- Wires for marking and locating breast tumors.
- Tubing for a range of medical applications.

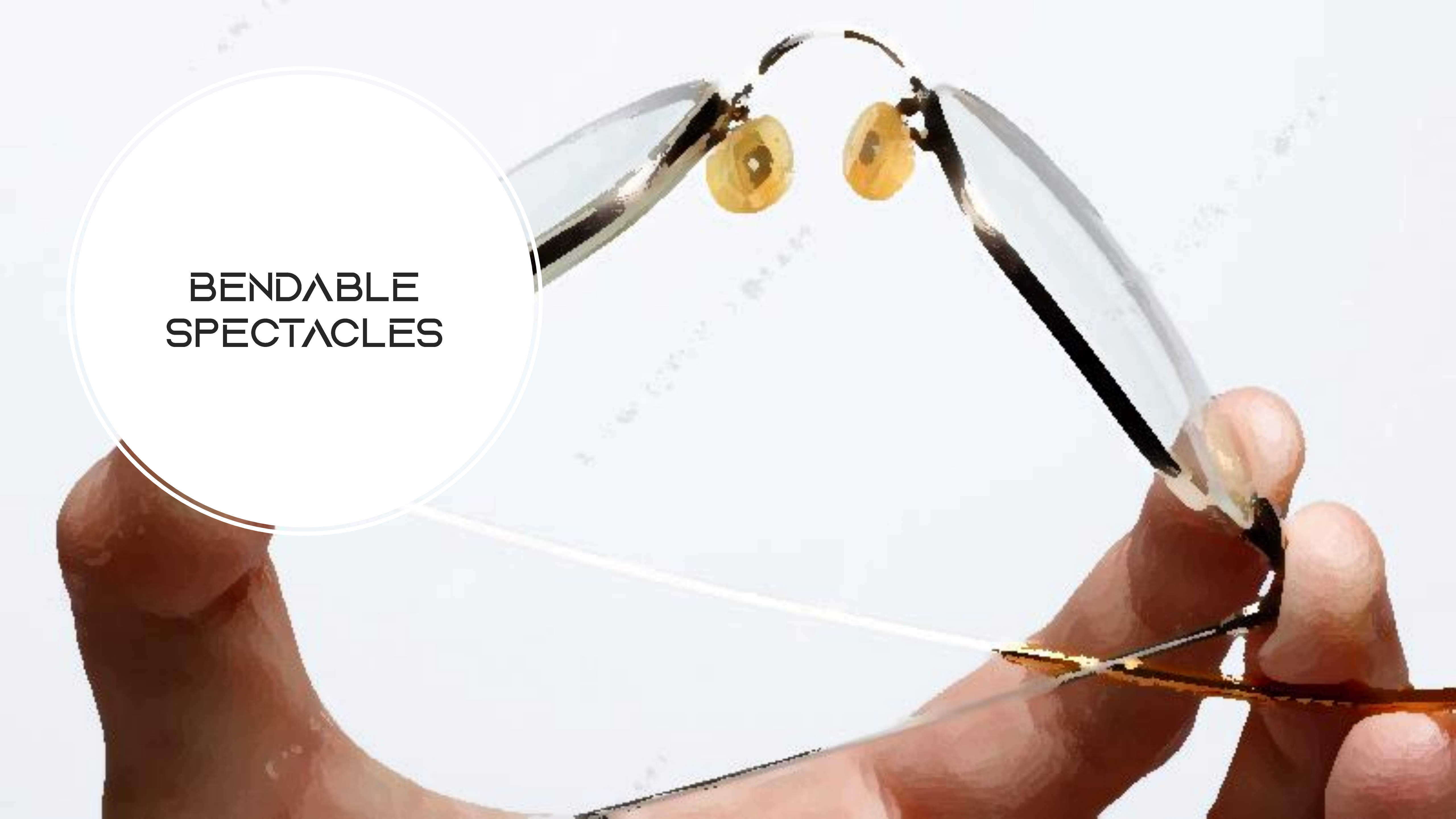
Possibly on Mars someday?



In Rovers as well as Regular Wheels



BENDABLE SPECTACLES



Thank You for Listening Patiently !