Wrought Nickel-Titanium Alloy

It is known as Nitinol. It was introduced as wire for orthodontic appliances in 1972. It is characterized by its high resiliency, and limited formability. The industrial alloy is 55% nickel and 45% titanium. A number of variations of Ni-Ti alloy have been developed in dentistry.

The mechanical properties of an orthodontic nickel-titanium alloy are compared with those of stainless steel; it has the lowest elastic modulus and yield strength but the highest spring back.

Dental applications: → **Orthodontic wires**

Nitinol → **Ni- Nickel**

Ti- Titanium

NOL- Naval Ordnance Laboratory

-Orthodontic wire alloys contain small amounts of other elements, such as copper and chromium.

NITINOL

In orthodontic applications

1 . Requires fewer arch wire changes.
2 . Requires less chair time.
3 . Shortens the time required to accomplish the rotations and leveling
4 . Produces less patient discomfort.

Mechanical Properties

1. **high resilience**⟶ Permanent bends are difficult
2. **high ductility**⟶ ability to undergo substantial work hardening
3. **very low elastic modulus**⟶ results in very low forces

-and because of the very low elastic modulus, the spring back or elastic range available for tooth movement is much greater for Nitinol compared with similarly constructed and activated appliances from stainless steel and Co-Cr-Ni alloys.

NICKEL-TITANIUM ALLOYS

2 forms of NiTi alloys

1. Martensite - Body centered cubic/tetragonal lattice
2. Austenite – Face centered (close packed hexagonal)

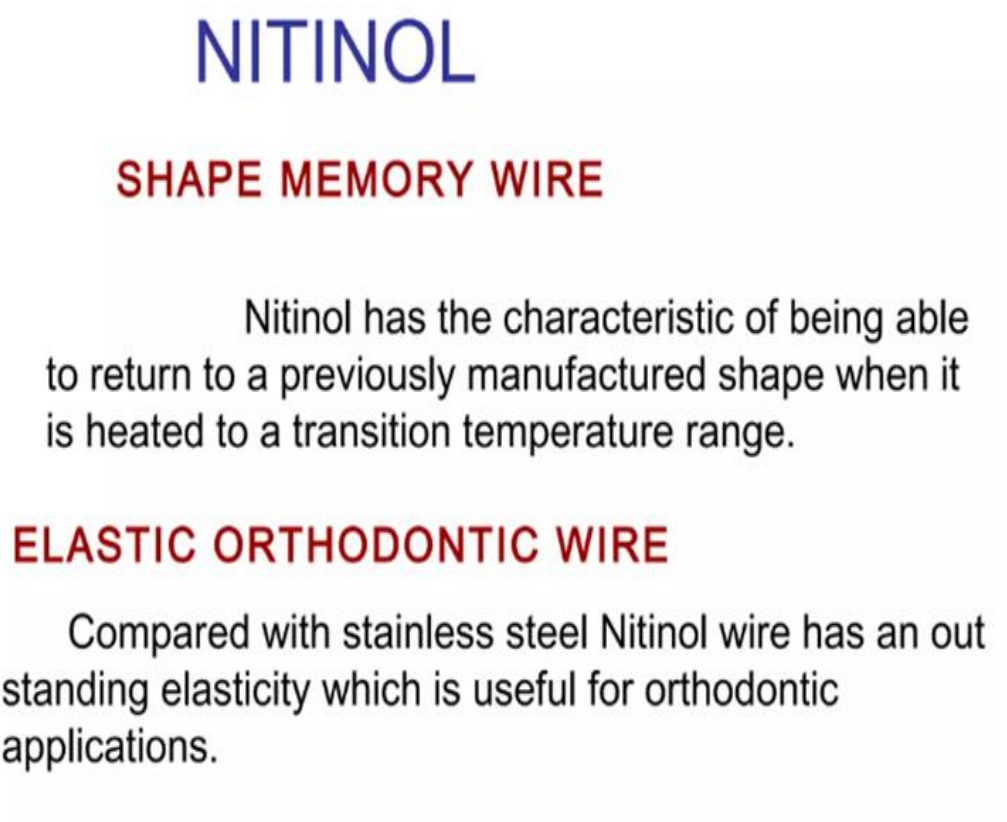
'R' phase – Rhombohedral

"SMART MATERIALS"

The transformation between the austenitic and martensitic forms of Nitinol alloys can be induced by both temperature and stress.

Austenitic NiTi is the high-temperature, low-stress form, and

martensitic NiTi is the low-temperature, high-stress form



Wrought stainless steel Alloy

Steel is an iron–carbon alloy. Stainless steel alloy is an alloy of iron and carbon that contains chromium, nickel, and manganese.

- **Usually, stainless steel alloys are not cast but are used in the wrought form. They are processed in wrought form, through rolling or drawing.**

- **The corrosion resistance of stainless steel is attributed largely to the presence of chromium in the alloy.**
- **About 11% chromium is needed to produce corrosion resistance in pure iron, and the necessary proportion is increased with the addition of carbon to form steel.**
- **Chromium resists corrosion well because of the formation of a strongly adherent coating of oxide on the surface, which prevents further reaction with the metal below the surface. The formation of such an oxide layer is called passivation.**
- **The soldering of stainless-steel wires requires skill, and the use of suitable materials is essential.**
- **Gold & Silver solders may be employed to form the union.**
- **Cleaning and polishing of stainless-steel appliances are troublesome operations that become necessary after soldering, heat treating, or periods of service in the mouth,**
- **The appliance may be pickled in warmed nitric acid, but a gray stain finish will result that requires mechanical brushing with a fine abrasive to restore the luster of the original material.**

Dental applications → **Orthodontic wires and brackets.**

Types of Stainless Steels

Based on the previously described crystal structures formed by iron and carbon atoms, there are three major types of stainless steel:

Ferritic Stainless Steels. **These alloys provide good corrosion resistance at a low cost. They cannot be hardened by heat treatment or readily work-hardened. Consequently, they have little application in dentistry.**

Martensitic Stainless Steels. **These alloys can be heat-treated in the same manner as plain carbon steels, which results in high yield strength and hardness for use in surgical and cutting instruments.**

Austenitic Stainless Steels. **The addition of nickel stabilizes the austenite phase on cooling of the alloy. The austenitic stainless steels are the most corrosion-resistant of the three major types. Austenitic stainless steel is preferred for dental applications**

because it has the following properties:

(1) greater ductility for more cold working without fracturing,

(2) greater strength from cold work,

(3) greater ease of welding,

(4) ability to overcome sensitization,

(5) less critical grain growth, and

(6) comparative ease of reshaping.

Properties

1. **Corrosion resistance can be increased further by the following means:**
   a. **increasing chromium content to more than 11%.**
   b. **adding nickel to at least 8%.**
   c. **adding molybdenum (which also improves resistance to**
2. **Strength Stainless steel is strong, about 3 times stronger than ordinary steel.**
3. **Melting point range goes from 1,400 to 1,530 °C**
4. **Conductivity: lower electrical conductivities than copper.**
5. **Magnetism: Ferritic Stainless Steels and Martensitic Stainless Steels are magnetic while Austenitic Stainless Steels is usually non-magnetic.**
6. **Wear**
7. **Density: The density of stainless-steel ranges from 7,500kg/m^3 to 8,000kg/m^3 depending on the alloy.**