

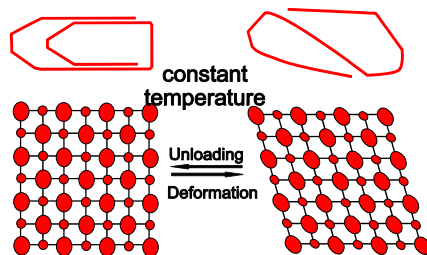
Memory-Metalle GmbH

INFO SHEET No. 5

The memory effects - an introduction

Products with shape memory alloys are quite common and most people might have used or at least saw some of them. For instance eye-glass frames or cell phone antennas made from „superelastic“ NiTiNOL (trade name for the standard alloy Nickel-Titanium) are nowadays really successful. The probably more popular „thermal shape memory effect“ characterized by the extraordinary ability of metals to recover any shape upon heating is less often applied in commercial products. Both effects can be achieved in one and the same alloy by special „thermomechanical treatment“. This special metallurgical treatment gives the alloys their particular properties and is of high importance for the success of the respective application.

The Superelasticity or Mechanical Memory



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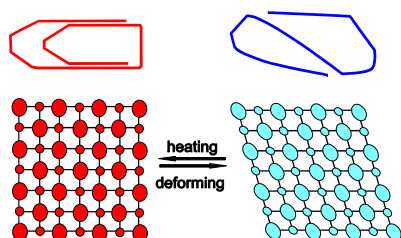
The „mechanical“ Memory Effect is initiated through an external force and leads to huge elastic strains of the alloy.

the availability of thin-walled tubing the high elasticity the stents can be folded into of catheter sheeth and pushed into the vessel, where they expand and provide a force to keep the vessel open.

The superelastic effect of memory alloys is characterized by the impressive amount of possible „elastic“ strain, which is more than 20x higher compared to conventional materials. It is beyond elasticity, therefore called „Superelasticity“. The effect is based on a internal transformation of the crystal structure, which is called „Austenite“ in the initial condition and which transform to the „Martensite“ (this phase is well-known from steel hardening) if external stresses affect the material. The phase transformation is related to the appearance of a pseudo-elastic strain, giving the effect its name superelasticity. After releasing the stress the material recovers the initial shape and temperature changes are not necessary for the occurrence of the effect.

The presently most interesting applications of the superelastic effect can be found in medical implants and instruments, where e.g.

market of stents has opened for the Memory Alloys. Due to the



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The „thermal“ Memory Effect occurs upon heating of a Memory metal, which has been previously deformed „plastically“. A high specific mechanical work is generated.

very high force output. However, the generation of very high forces is not the strength of shape memory actuators, as most applications of memory metal make use of max. 10 N force.

The Thermal Memory-Effect (One Way- or Two Way Effect)

Even more spectacular than the mechanical memory effect is the „thermal memory effect“: after an obvious „plastic“ deformation of e.g. a paper clamp or a spring made of memory metal wire the alloy recovers the initial shape upon heating with a hot tea, a lighter or an electrical current. In contrast to the competing Bi-metal the deformation is not limited to just pure bending: tensional and torsional deformations are also possible and even mixtures of all kinds of deformation are useable. Furthermore, the materials generate very high forces if the shape recovery is hindered by an external mechanical component. Thus, a 4 mm diameter actuator wire made of „NiTiNOL“ memory alloys is able to lift up to 1 ton of load for at least one time. In order to prevent „amnesia“ of being the limiting factor for the life cycle of the actuator, the actuator load in this example should be reduced to about 150 kg, which is still a