Unit – V New Engineering Materials

Topic: 8 SMA Characteristics

SHAPE MEMORY ALLOYS

Shape Memory Alloys (SMAs) are the alloy which changes its shape from its original shape to new shape and while heating/cooling it will return to its original shape. Example: Nitinol

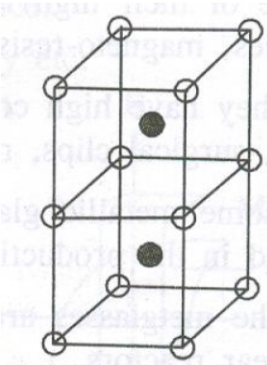
Transformation temperature

The temperature at which the SMA switches from new shape to its original shape is called transformation temperature or memory transfer temperature.

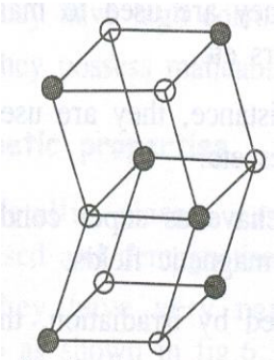
PHASES OF SMA

(i)Austenite

- Austenite is the solid solution of carbon and other alloying elements in γ - iron
- It crystallizes into cubic crystal structure
- It is a high temperature phase and it is hard in this phase



Austenite structure



Martensite structure

(ii) Martensite

- Martensite is an interstitial super solution of carbon in α – iron.
- It crystallizes into twinned structure
- It is a low temperature phase and it is soft in this phase

PROCESSING OF SMA

Shape memory effect

At lower temperature the SMA will be in martensite structure and when it is heated it will change its shape to Austenite structure and while cooling it will again return to martensite form. This effect is called Shape memory effect.

Characteristic temperatures

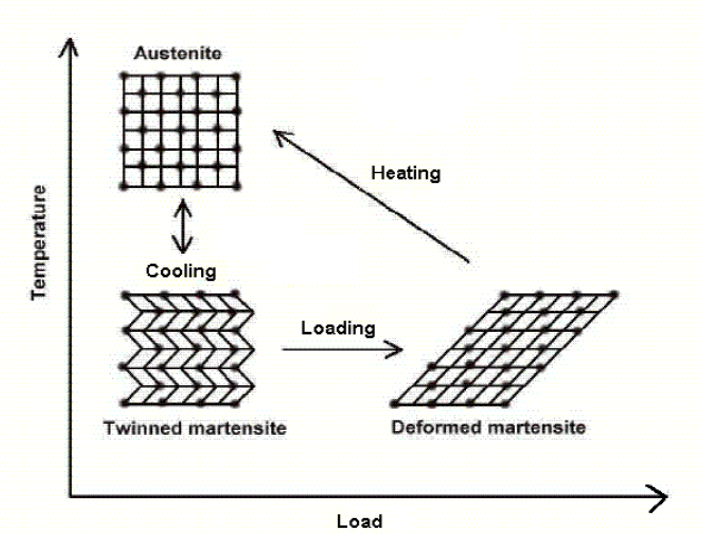
M_f=Martensitic Finish

M_s=Martensitic Start

A_s=Austenitic Start

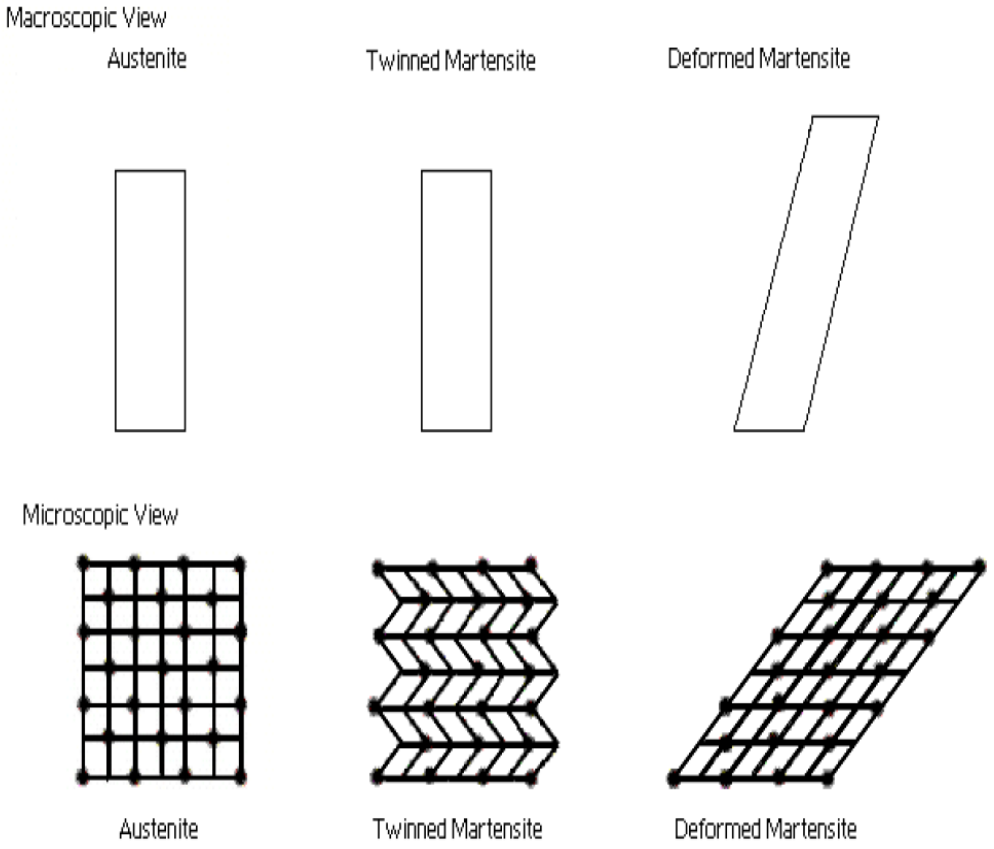
A_f=Austenitic Finish

Microscopic Diagram of the Shape Memory Effect



The shape memory effect is observed when the temperature of a piece of shape memory alloy is cooled to below the temperature Mf. At this stage the alloy is completely composed of Martensite which can be easily deformed. After distorting the SMA the original shape can be recovered simply by heating the wire above the temperature Af. The heat transferred to the wire is the power driving the molecular rearrangement of the alloy, similar to heat melting ice into water, but the alloy remains solid. The deformed Martensite is now transformed to the cubic Austenite phase, which is configured in the original shape of the wire.

Microscopic and Macroscopic Views of the Two Phases of Shape Memory Alloys



Martensite, is the relatively soft and easily deformed phase of shape memory alloys, which exists at lower temperatures. The molecular structure in this phase is twinned in which the configuration is as shown in the middle of Figure. Upon deformation this phase takes on the second form shown in Figure, on the right. Austenite, the stronger phase of shape memory alloys, occurs at higher temperatures. The shape of the Austenite structure is cubic, the structure shown on the left side of Figure. The un-deformed Martensite phase is the same size and shape as the cubic Austenite phase on a macroscopic scale, so that no change in size or shape is visible in shape memory alloys until the Martensite is deformed.