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Effect Of Rolling On Ni-Ti-Fe Shape Memory Alloys Prepared Through Novel Powder Metallurgy Route

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Abstract

This study is concentrated on the preparation of Ni-Ti shape memory alloys with the addition of different atomic wt.% of iron in place of atomic wt.% of Nickel through novel powder metallurgy route. Further rolling was done on hot pressed sample in rolling mill. The microstructure and the mechanical properties of the hot pressed and further rolled sample of Ni-Ti and Ni-Ti-Fe were studied. The DSC and XRD analysis was also done on the hot pressed and rolled samples. The samples were prepared by the powders of Nickel, Titanium and Iron mixed in hexagonal trembler and further cold compaction on hydraulic press.
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*Keywords:*Nickel, Titanium, Iron powders, Shape memory alloys (SMA), hot pressing, XRD, DSC, and hot rolling.

Introduction:

Thermo responsive shape memory alloys are the types of alloys which remember their shape during heating. The shape memory alloys are those which revert to their original shape on heating. Shape memory alloys (SMA) attracted much attention in recent years, since they are smart (or intelligent) materials, as well as functional materials, which already exist [1]. Since the unique shape memory effect (SME) and super elasticity (SE) realized in these alloys are caused by the martensitic (or displacive) transformation (MT) and its reverse transformation [4]. The shape memory alloys are generally four types: (a) Ni-Ti SMAs (b) Cu-based SMAs and (c) Fe-based SMAs and (d) Shape Memory Polymer.

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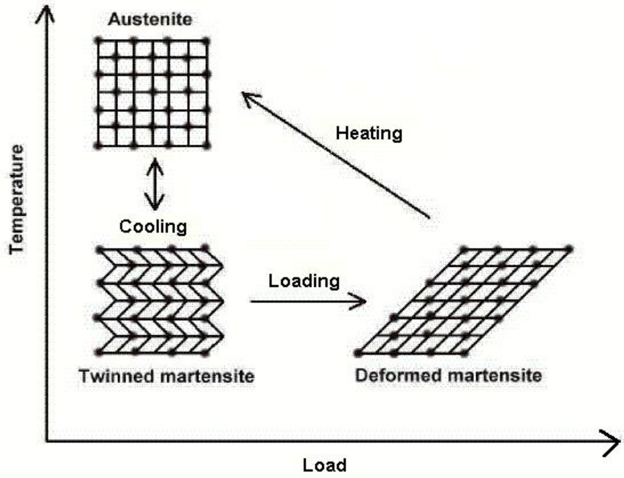

Fig. 1 Schematic representation of SMAs

From as shown in the above Fig 1. Shape memory alloys (SMA) have drawn increasing interest from both the academic community and commercial world due to their unique properties [8]. In 1932, a Swedish physicist Arne Olander discovered an interesting phenomenon when working with an alloy of gold and cadmium [7]. On heating, the Au-Cd alloy could be return to the original shape after plastically deformed. Further research revealed other materials that demonstrate this phenomenon. In 1961, a group of U. S. Naval Ordnance Laboratory researchers lead by William Beuhler have put forwarded a significant discovery in the field of SMAs which reveals the superelasticbehavior and high strain recovery rate upto 300% in the Shape Memory Polymer.

Crystal Structure of SMAs:

At high temperatures, Ni-Ti SMA assumes an interpenetrating primitive cubic crystal structure referred to as austenite (also known as the parent phase) [5]. At low temperatures, it spontaneously transforms to a more complicated monoclinic crystal structure known as martensite. The temperature at which austenite transforms to martensite is generally referred to as the transformation temperature.In Cu-Al-Ni SMAs high temperature austenite phase have monoclinic unit cell in four DO_3 unit cells and martensitic phase have orthorhombic structure as shown in the below Fig 2a and Fig 2b.

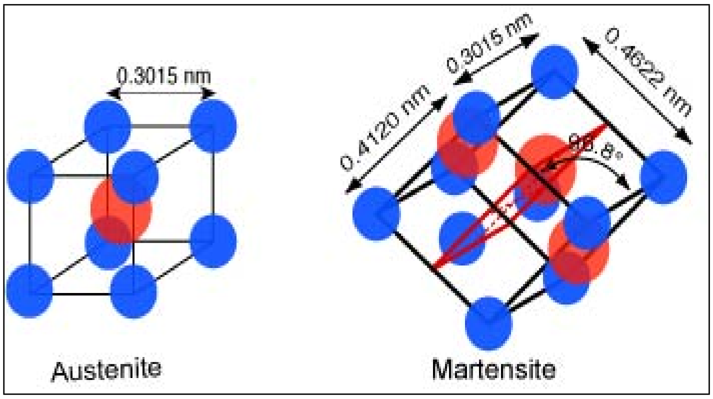

Fig. 2a: Structure of Ni-Ti SMA

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