

Novel Iron Based Shape Memory Alloys with low activation (phase transformation) temperature

Invention

Empa has developed a novel iron based shape memory alloy (SMA) with excellent shape memory properties and relatively low (120°C–200°C) phase transformation temperatures. The optimized composition and thermal treatment developed for this alloy lead to very good recovery stress (up to 500 MPa). This alloy is suitable for applications e.g. in concrete structures, for which moderate phase transformation temperatures are needed, or in mechanical engineering (e.g. clamping devices) where high recovery stresses are required.

Background

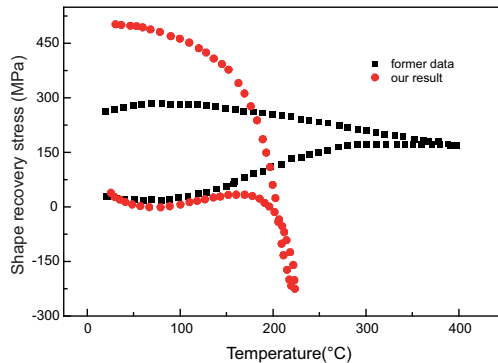
Shape memory alloys are applied among other things as actuators. They can be used for devices that transform thermal energy directly into mechanical work. These alloys are used in special applications, where conventional actuators such as electric or hydraulic actuator cannot be used due to space or weight limitations. SMAs are normally based on Nickel Titanium (NiTi) alloys, which are very expensive. NiTi alloys are generally activated at temperatures ranging from approximately - 50°C to approximately 150°C. Iron based SMAs would be a cost-effective alternative to alloys based on NiTi. However, the temperature range for activation of conventional iron based SMAs is significantly above 200°C, and shape memory properties are rather poor in comparison with NiTi alloys.

Advantages

The iron based SMA developed at Empa has significantly lower activation temperatures than conventional similar alloys, in the range of 120°C–200°C. The new alloy developed at Empa combines the low activation temperature range of NiTi alloys with the low cost of iron based SMAs as well as an excellent shape recovery and high recovery stress. These properties of the new alloy developed at Empa make it an excellent candidate for large volume applications.

Applications

These new alloys were developed with the needs of civil engineering applications in mind. The cost of the alloy is a parameter of paramount importance, given the large volumes and low value density of most civil engineering applications. The reduced activation temperature makes the alloy suitable for applications in various industrial sectors, such as civil and mechanical engineering, automotive applications or transportation. Possible applications are anchors for tensile members, prestressing of concrete structures, dowels, pipe couplings, safety valves. The alloy is expected to exhibit good corrosion resistance due to the relatively high level of Nickel and Chromium used as alloying elements.



Comparison of shape recovery stress of the optimized alloy with the performance of existing results (source for former data: 5)

Ownership

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Keywords

Smart Material, Iron based Shape Memory Alloy (SMA), low phase transformation temperature, low cost SMA, civil engineering, automotive application, pre-stressing, joining

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