

4.4 Super-Elastic Tire using Memory Alloy

Statement: The novel use of shape memory alloys capable of undergoing high strain as load bearing components, instead of typical elastic materials, results in a tire that can withstand excessive deformation without permanent damage.

Problem: Commonly used elastic-plastic materials (e.g. spring steels, composites, etc.) can only be subjected to strains on the order of $\sim 0.3-0.5\%$ before yielding.

Solution: Use shape memory alloys capable of undergoing significant reversible strain (up to 10%), enabling the tire to withstand an order of magnitude more deformation than other non-pneumatic tires before undergoing permanent deformation.

Technology description: This technology comprises a non-pneumatic, compliant tire utilizing shape memory alloys (mainly nickel-titanium, NiTi, and its derivatives) as load bearing components. Hence, the use of a NiTi shape memory alloy yields a super-elastic tire that is virtually impervious to plastic deformation. In addition, the utilization of shape memory alloys provides enhanced control over the effective stiffness as a function of the deformation, providing increased design versatility. For instance, the Super-elastic Tire can be made to soften with increased deflection, reducing the amount of energy transferred to the vehicle during high deformation events. In addition, the use of shape memory alloys in the form of radial stiffeners, as opposed to springs, provides even more load carrying potential and improved design flexibility. This type of compliant tire would allow for increased travel speeds in off-road applications.

Benefits of the product: The tire made with memory alloy are:

- Safe: Eliminates the possibility of puncture failure.
- Strong: Can withstand excessive deformation.
- Robust: Can be configured for high traction on various terrains.
- Simple: Eliminates the need for air.
- Versatile: Tire stiffness can be designed to limit energy transferred to vehicle.
- Lightweight: No inner frame needed for the tire/wheel assembly.

Areas of application: The shape memory alloy tires can be utilized in:

- Vehicles for all-terrain.
- Military, construction, automobile, agriculture, heavy equipment.