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APPLICATION OF SHAPE MEMORY ALLOY IN HYPERSONIC VEHICLES WITH SCRAMJET TECHNOLOGY

Abstract

Advances in propulsion system, aerothermodynamics and flight control design allowed aerospace vehicles to operate at hypersonic speed, however many problems still existed due to aerodynamic heating and shock wave interactions resulting in high temperatures in the airframe causing thermal stresses and rapid ablation. Shape memory alloys have become the main class of smart materials in the aeronautical arena due to their excellent mechanical properties to withstand high speed and temperature. The use of these materials, especially in the technological field, provides countless applications because they present adaptive behavior to adapt to environmental changes. These are materials that have the ability to react to an external stimulus in a way similar to biological reactions. Materials with Shape Memory Effect (SME) can recover their original shape even after undergoing large deformations, through a temperature and/or stress field in the alloy's phase transformation range. This is because the alloys with this effect have two stages in the phase transformation that are called Martensitic temperature and Austenitic temperature. In Martensite, a transformation occurs without diffusion, only the coordinated movement of atoms by the shear mechanism. It is the phase known for having low temperatures and a monoclinic crystalline structure. Due to mechanical loading or temperature variation, the internal microscopy structure is altered, presenting a twinning accommodation, that is, characterization by the stacking faults, not showing the rupture of chemical bonds, making the alloy reversible. Austenite has a high temperature phase, a cubic crystalline structure, and more crystallographically ordered, offering greater resistance to possible deformations. From a microscopic and macroscopic point of view, the structure remains unchanged when exposed to mechanical loads, and it can be said to be an elastic phase. Given the synthesis discussed in this summary, it is possible to state that the use of shape memory alloys in the reference technology demonstrator allows it to be suitable for various flight regimes. The IEAv - Institute for Advanced Studies in partnership with the IME - Military Institute of Engineering, studies the possibility of producing an alloy with shape memory effect through selective laser fusion processes used in additive manufacturing with the objective of performing experimental tests and parameter studies.