

66th International Astronautical Congress 2015

SPACE PROPULSION SYMPOSIUM (C4)
Propulsion Technology (1) (3)

Author: Mr. OFER LIVNE

Rafael Advanced Defense Systems Ltd., Israel, oferliv@rafael.co.il

Mr. Leonid Rabinovich

RAFAEL, Israel, leonidr@rafael.co.il

Prof. Lior Kogut

Rafael Advanced Defense Systems Ltd., Israel, liorko@rafael.co.il

Mr. Valentin Nov

Rafael Advanced Defense Systems Ltd., Israel, valent@rafael.co.il

Mr. David Reiner

Rafael Advanced Defense Systems Ltd., Israel, reinerd@rafael.co.il

NEW HORIZONS FOR SMA (SHAPE MEMORY ALLOY) IN SPACE PROPULSION APPLICATIONS

Abstract

Satellites nowadays use diverse thrust methods for propulsion; chemical decomposition to accelerate gases out of a nozzle, cold or hot gas and electrical acceleration of ionized atoms. These approaches involve flowing media from a storage tank, thus different valves are needed to control the flow. To allow the opening of the propellant tank, pyrotechnic valves are commonly used. These valves keep the tank sealed until being used as a single shot device. However, pyrotechnic valves have major disadvantages such as inducing a high shock level to the satellite. Space propulsion industry requires high performance valves that can be inert, reliable, testable, safe, and media compatible. Moreover, strict size, mass, and energy consumption are imposed. SMA technology was marked in Rafael as a leading solution to these requirements. SMA's smooth operation is the ultimate benefit of this technology. SMA alloys "remember" their original shape, and are able to repeatedly deform to a predefined size, under heating. Thus, different applications can be derived. Here – applying predefined force under predefined extension to shear a nipple and allow fluid flow. Rafael combined its space propulsion systems heritage with its advanced SMA knowledge to allow design and manufacturing of such a simple yet highly advanced valve. The development of the SMA valve encircled various engineering disciplines, to include achievements such as; SMA production and inspection technological developments; mechanical design of unique sub assemblies; dedicated metallurgical inspections, to allow wide media compatibility; advanced welding techniques of various metals of very small parts; dedicated clean-room production methods; specialized NDT processes; and strict quality assurance processes and methods throughout the development and manufacturing processes. Following these prominent achievements, Rafael's space division initiated development of a whole product line for various valve applications such as normally closed, switching valve, and compatibility for various levels of pressure (down from zero up to hundreds of Bars) alongside various other SMA products for different applications. This paper will describe the technology, its application and the various programs utilizing SMA technology. It will also present the trades' selection, the manufacturing challenges and the qualification campaign.