

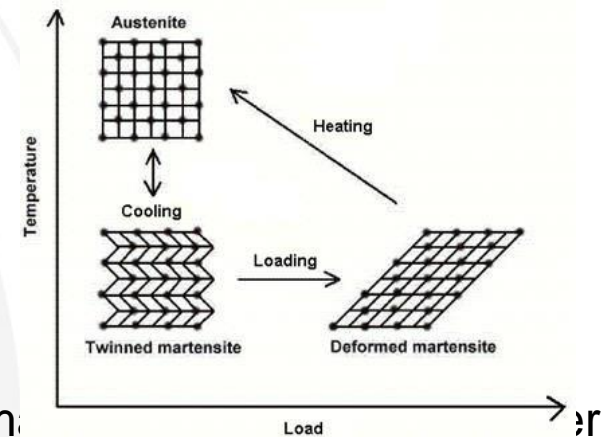
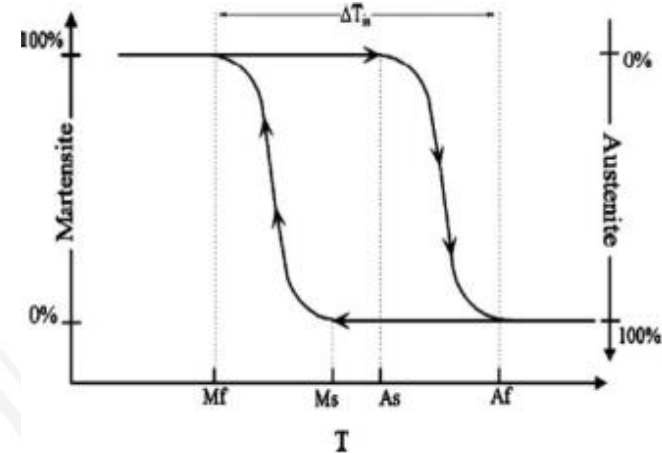
Shape Memory Alloy Technologies for Electric Propulsion

AGENDA

- Shape Memory Alloys
- A high temperature SMA: SMARQ®
- Shape Memory Alloy valves (advantages and drawbacks)
- SMA NC/NO one-shot Valves concept
- SMA Latch valves concept
- Other mechanisms for Electric Propulsion

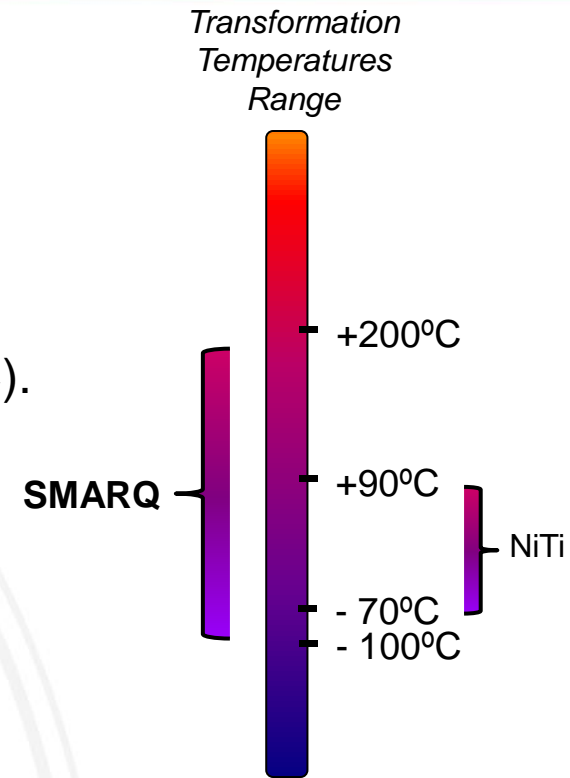
SHAPE MEMORY ALLOYS

- Thermoelastic martensitic transformation
 - Thermal process
 - Transition temperatures
- Main properties
 - Shape Memory Effect
 - Used in active actuators
 - Pseudo-elastic effect
 - Used in passive elements
- Shape Memory Effect
 - Deformation forced to material in cool phase (martensite) during heating.
 - Change of crystal structure produces a macroscopic effect: mechanical work
- Limitation of available NiTi based alloys:
 - Transformation temperature ($T < 90^{\circ}\text{C}$) limits working temperature range.



A high temperature SMA: SMARQ®

- Novel SMA material:
 - Low cost production procedure.
 - Extended operation temperature range (up to 180°C).
 - Higher stroke capabilities.
 - Lower thermal hysteresis.
- Applications
 - Space actuators with extended temperature range
 - Hold Down and Release Actuators
 - Deployment Actuators
 - Valves
 - Cryogenic actuators
 - Dampers,...



Shape Memory Alloy valves

Advantages

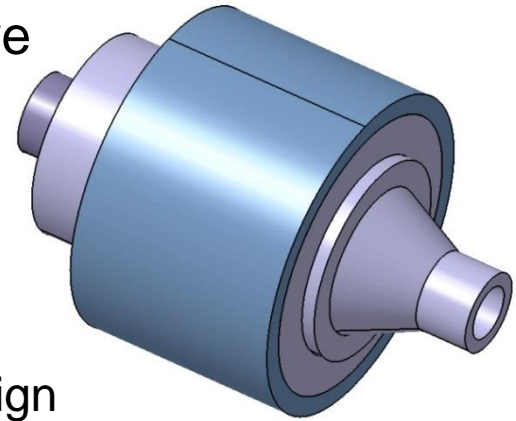
- Low complexity
- Optimization of mass & volume
 - High force to mass ratio
 - Enables compact designs
- Immune to EM environment
- EM clean
- Quiet operation
- High reliability
- Non-explosive
- SMA Flight heritage

Drawbacks

- Moderate speed & power consumption
- Moderate lifetime
 - Up to 10^5 cycles if properly designed
- Limited Thermal environment of NiTi
 - Solved with SMARQ[®]
- Performance dependent of thermal conditions

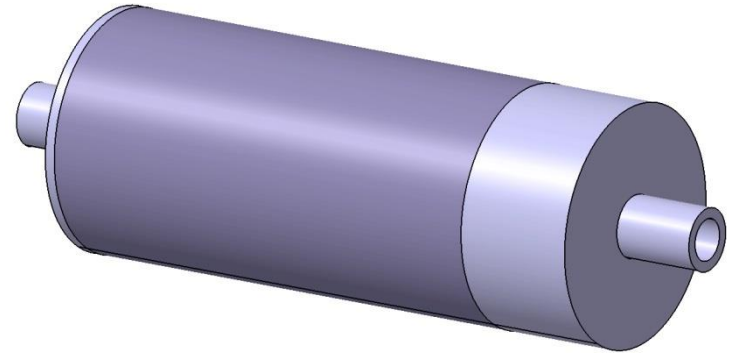
SMA NC/NO one-shot valves concept

- Replacement of pyro-valves: Non-explosive
- Low shock
- High reliability
- Simple, compact design
 - In-line option vs traditional transversal design
- Lightweight
- Low volume
 - External dimensions: $\phi 24 \times 30\text{mm}$
- Actuator redundancy
- Resettable by hand
- TRL3-4
- BOL and EOL valves



SMA LATCH valves concept

- Non-explosive
- Simple, compact design
 - In-line configuration
- Lightweight
- Low volume
 - External dimensions: $\phi 23 \times 54\text{mm}$
- Bi-stable, multiple O/C cycles
- Actuation redundancy options
- Moderate actuation speed
- TRL 3-4



Release actuators for electric propulsion deployment mechanisms

▪ HDRM – REACT:

- Hold Down and Release Mechanism based on SMA
- Non-explosive
- Low shock
- No ITAR
- Fully resettable by user
- 3 different sizes:
 - 5kN, 15kN, 35kN
- Two different temperature versions:
 - Standard operation range: -90°C , $+70^{\circ}\text{C}$
 - Extended operation range (-90°C , $+120^{\circ}\text{C}$).
- Qualification campaign on-going (to be completed in Q1 2018)



Release actuators for electric propulsion deployment mechanisms

▪ PIN PULLER:

- Hold Down and Release Mechanism based on SMA
- Non-explosive
- Low shock
- No ITAR
- Fully resettable by user
- 4 different pull forces:
 - 25N, 50N, 100N and 500N
- Two different temperature versions:
 - Standard operation range: -90°C , $+70^{\circ}\text{C}$
 - Extended operation range (-90°C , $+120^{\circ}\text{C}$).
- TRL 9 Qualification scheduled in Q4 2018



The logo for Arquimea, featuring the word "ARQUIMEA" in a bold, sans-serif font. The letter "Q" is stylized with a small orange square and a white arrow pointing to the right, integrated into its design.

ARQUIMEA

Passion for Technology

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