2017 PhD Thesis Research Topic (1)

Title: Study on the **energy dissipation** and **fatigue properties** of shape memory alloys

Subfield: Mechanics, Energy and Materials Science.

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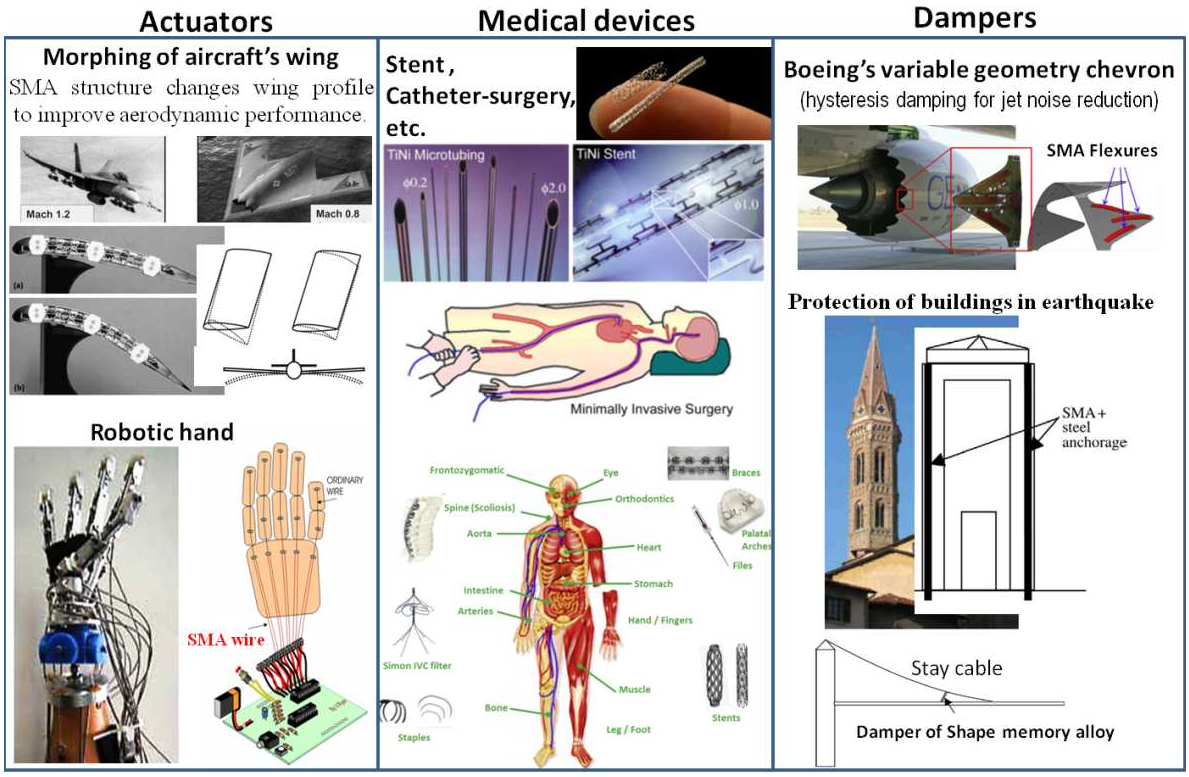
Polycrystalline shape memory alloys (SMA) are multi-functional materials which are able to "remember" (recover) its original shape when subjected to thermo-mechanical loadings. The properties of shape memory and superelasticity lead to many applications in automotive, aerospace, robotic and biomedical devices (examples in the following figure). However, not all the applications have the same requirements, for example, damping applications require a large hysteresis (large energy dissipation) while the medical-devices/actuators need a small hysteresis to have high reliability/efficiency. But all the applications require good fatigue properties (i.e., the materials can sustain many working cycles). Preliminary studies[3-5] imply that the fatigue behaviours are related to the hysteresis (energy dissipation). The goals of this research are to understand the governing physical mechanisms and to find out the relation between the macro-properties (hysteresis and fatigue) and the microstructures, via systematic macro-experiments, micro-observations, and theoretical modelling. Finally, criteria/guidelines for controlling/modifying the material properties can be obtained.



Representative publications on the research topic:

[1] **Y.J. He**, Q.P. Sun. "On non-monotonic rate dependence of stress hysteresis of superelastic shape memory alloy bars". *International Journal of Solids and Structures* 48, 1688-1695 (2011).

[2] **Y. J. He**, X. Chen, and Z. Moumni. "Two-dimensional analysis to improve the output stress in ferromagnetic shape memory alloys". *Journal of Applied Physics* 110, 063905 (2011).

[3] H. Yin, **Y.J. He**, Q.P. Sun, "Effect of deformation frequency on temperature and stress oscillations in cyclic phase transition of NiTi shape memory alloy", *Journal of the Mechanics and Physics of Solids* 67, 100–128(2014).

[4] L. Zheng, **Y.J. He**, Z. Moumni "Lüders-like band front motion and fatigue life of pseudoelastic polycrystalline NiTi shape memory alloy" *Scripta Materialia* 123, 46–50 (2016).

[5] H. Yin, **Y.J. He**, Z. Moumni, Q.P. Sun "Effects of grain size on tensile fatigue life of nanostructured NiTi shape memory alloy" *International Journal of Fatigue* 88, 166–177 (2016).