# Non-linear thermo-mechanical behaviour of polycrystalline shape memory alloys undergoing complex loadings

Shape memory alloys (SMAs) are a particularly appealing and interesting class of intermetallic smart materials capable of demonstrating large recoverable shape changes while producing hysteresis. This unique behaviour is a result of martensitic transformation/orientation/reorientation/self-accommodation in response to stress and/or temperature changes introducing functional phenomenon of shape memory effect (SME) and pseudo-elasticity (PE). These unique characteristics of SMAs together with their good biocompatibility have made them attractive for use in many engineering applications such as sensors, actuators, energy absorption, biomedical devices and micro-electro-mechanical systems. In order to assess the potential of SMAs in advanced engineering applications especially under uniaxial and multi-axial loading conditions, several experimental/numerical studies have been conducted over the past two decades. However, in many real engineering applications, SMA devices experience proportional/non-proportional multi-axial cyclic loadings. The main objective of this proposal is to conduct a thermo-mechanical analysis through a series of uniaxial, cruciform quasi-static biaxial as well as proportional/non-proportional cruciform biaxial cyclic tests on SMA materials and replicate experimental observations of material flow behaviour by developing phenomenological constitutive models. In doing so, behaviour of SMA sheet metal in a biaxial stress space is represented by providing: (i) a yield criterion, correlating the stress components when the yielding occurs; (ii) a flow rule, connecting the components of the strain-rate and stress; (iii) a hardening rule, describing the evolution of the initial yield locus.

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