MA 1175/79-2
EG 101/32-2
FR 2675/8-2

New Quinary and Senary High Entropy Shape Memory Alloys (HE-SMA) – Exploring and Exploiting Martensitic Transformations and Shape Memory Effects in Chemically Complex Systems

The proposed research focusses on understanding and exploiting the mechanisms that govern the behavior of high entropy shape memory alloys (HE-SMAs). The long-term objective is to establish these materials as a new class of engineering alloys, which have potential for wide spread applications. Three scientific objectives characterize the proposed research. The alloy development activity is based on a novel screening approach in order to develop new quinary and senary shape memory alloys. This continuous background activity involves high precision melting activities and addresses the need to study the microstructural evolution along the ingot metallurgy processing chain, including the processes that (i) govern the solidification of senary melts and (ii) occur during post-cast thermo-mechanical treatments. The three scientific objectives can be briefly described as follows: Firstly, to identify new compositions for HE-SMAs that outperform conventional SMAs in terms of high transformation temperatures, large shape memory strains and good functional stability. Secondly, to use advanced characterization methods (in addition to standard methods: advanced analytical high-resolution SEM and TEM, atom probe tomography) to clarify the effect of chemical complexity on the elementary transformation and deformation processes that govern and affect the martensitic phase transitions. The third objective aims at advancing shape memory technology. This part focuses on studying the influence of chemical complexity on the relevant shape memory effects (one-way effect, pseudoelasticity) and aims at developing a HE-SMA demonstrator, which allows appreciating and quantifying the functional performance of a spring actuator. In the fundamental part of the proposed work, open questions from the two fascinating research areas high entropy alloys and shape memory alloys are linked. Specifically, the way in which chemical complexity affects mechanical and functional properties of HE-SMAs and how chemical complexity can be exploited to promote HE-SMA technology will be explored. From a technological point of view, extrusion processing will be applied to compositionally complex HE-SMAs, which promises to provide materials with further increased ductility. Moreover, a spring actuator will be built and characterized, with a special focus on functional fatigue, which limits the exploitable service life of all shape memory alloys. The work programme proposed in this proposal is subdivided into 11 well-defined work packages, one of which is devoted to the interaction with other SPP projects.