BoKoMaT

24.09. – 25.09. 2025

_9

Prof. Dr. Jan Frenzel

Academic Senior Council
Leader Research group Materials Processing

Chair Materials Science and Engineering
Ruhr University Bochum

On the importance of alloy composition and microstructure optimization in shape memory technology

In this study, we present examples which demonstrate how the functional properties and performance of NiTi-based shape memory alloys (SMAs) depend on the composition and microstructure. There are cases where small or large concentration changes are required to achieve changes in transformation behavior. For instance, adding 0.1 at% of either Ni or Cr to a binary NiTi alloy can decrease the Ms temperature by over 10 K. In contrast, additions of more than 10 at% of either Pd or Pt are necessary to achieve an almost tiny increase in transformation temperatures. Varying the alloy composition affects more than just transformation temperatures. It also causes changes in lattice parameters, which govern the crystallographic compatibility between the lattices of austenite and martensite. A good crystallographic fit is important when a large number of functional cycles is required. A poor compatibility between the parent and product phase lattices accelerates the accumulation of defects which cause functional degradation, also referred to as functional fatigue. In the present work, we demonstrate that transformation-induced defect generation is also relevant for structural fatigue, which refers to the formation and growth of cracks that eventually cause material failure. Therefore, improving crystallographic compatibility can extend structural fatigue lives. Tuning the chemical composition is not the only way to improve the material's functional performance. Microstructural optimization creates material states that are more resilient to the high compatibility stresses associated with the martensitic transformation. Corresponding SMAs exhibit superior functional and structural fatigue performance.

The talk is based on various of our former publications. It also includes unpublished work.