INTERDISCIPLINARY CENTRE FOR ADVANCED MATERIALS SIMULATION

ICAMS special lecture

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Heterogeneous and homogeneous precipitation of Ni4Ti3 in NiTi shape memory alloys

Near-equiatomic NiTi shape memory alloys are of technical interest because the martensite start temperature can be adjusted by the Ni-content of the matrix through the precipitation of metastable Ni4Ti3 precipitates. It is well known that the Ni4Ti3 precipitates have a rhombohedral crystal structure and a lenticular disk-like morphology. The growth of the Ni4Ti3 precipitates occurs coherently on {111}-planes of the B2 lattice (high temperature phase of NiTi) and eight variants are observed. However, the precipitation behavior during thermo-mechanical treatments of near-equiatomic Ni-rich NiTi is rather complex and will be discussed for polycrystalline and single crystalline material with different Ni-concentrations. In polycrystalline Ni-rich NiTi alloys, a heterogeneous precipitation of Ni4Ti3 particles is observed. During heat treatment, the precipitates nucleate and grow preferentially near grain boundaries and at inclusions like Ti4Ni2O and TiC (which are always present in a technically relevant alloy) while the grain interior of the polycrystalline alloy remains essentially free of precipitates. Stress-assisted aging under a mechanical loading results in a homogeneous precipitation in terms of number density. Still a difference between grain interiors and regions near grain boundaries in terms of the appearance of precipitate variants is observed. Compression aging of single crystalline Ni-rich NiTi alloys in the [111]-direction of the B2-phase results in the formation of only one family of Ni4Ti3 precipitates. Details of a quantitative analysis of particle size, distance, and volume fraction after different aging times will be presented. For some of the material states, the influence of the Ni4Ti3 precipitates and the precipitation behavior on the martensitic transformations will be discussed.