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Towards sustainable NiTi metallurgy: Impurities, microstructural evolution and fundamental effects on phase transformation behavior

Research on recycling of important engineering materials has significantly intensified during the last years. To date, sustainability aspects related to nickel and titanium have been overshadowed by aluminum and steel recycling, as these metals dominate global markets. However, the production of both nickel and titanium is even more energy-intensive (Ni: up to 194 MJ/kg; Ti: 361 MJ/kg) and results in higher CO_2 emissions (Ni: up to 16.1 kg CO_2-e/kg; Ti: 35.7 kg CO_2-e/kg) by weight compared to common steels. Hence, this study addresses this gap by advancing NiTi metallurgy recycling research. Based on the critical stages in the life cycle relevant for contamination uptake, we investigate the influence of alloy chemistry, melting methods, surface states and surface optimization on recycling feasibility. We study impurity incorporation during arc melting (AM) and vacuum induction melting (VIM) recycling experiments using scanning electron microscopy (SEM) and differential scanning calorimetry (DSC). Special emphasis is placed on the analysis of impurity-related inclusions in NiTi using atom probe tomography (APT). Our results contribute to a better understanding of possible recycling approaches for NiTi.

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