Microstructure and mechanical properties of V-Si-B alloys with chromium additions

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The V-Si-B system has gained scientific interest as a new low-density, refractory metal-based structural intermetallic alloy system. The alloy design is strongly influenced and driven by the developments in the field of Mo-Si-B alloys and shares some interesting structural and microstructural features. Very recently, the formations of ternary eutectic V_{SS}-V_3Si-V_5SiB_2 microstructure has been reported which contains the same isomorphous phases as the ternary eutectic in the well-studied Mo-Si-B system: a refractory metal-based solid-solution phase (Mo_{SS} or V_{SS}) and the two intermetallic phases with either an A15 (Mo_3Si and V_3Si) or a $D8_l$ (Mo_5SiB_2 and V_5SiB_2) structure. However, while the Mo-Si-B-based ternary eutectic shows some oxidation resistance due to its intermetallic character, oxidation of the V-based eutectic is an even more serious issue. To address this problem, different amounts of Cr were added to an eutectic V-Si-B alloy to study the microstructural influence on the ternary eutectic reaction, the phase stability as well as the mechanical and oxidation properties as a function of Cr concentration. Alloys with Cr additions between 5 – 30 at.% were fabricated by conventionally arc-melting and were analyzed in the as-cast state or heat-treated at 1400°C for 100 hrs.

The present study is focused on the compressive stress-strain behavior of ternary eutectic V-Si-B alloys with 10, 20 and 30 at.% Cr additions. Compression tests were performed using an electro-mechanical universal testing machine and a constant crosshead speed corresponding to an initial (engineering) strain rate of 10^{-3} s^{-1}. The yield stresses were determined by the 0.2% offset method. The temperature dependence of its compressive yield stress between room temperature and 1000°C was investigated in the as-cast and annealed state (1400°C for 100 hrs) and compared to the Cr-free ternary eutectic alloys V-9Si-6.5B as well as V-Si-B alloys taken from the literature.