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Determining the ternary eutectic alloy composition on the Mo-rich side of the Mo-Si-B system (#87)

Georg Hasemann[1], Florian Gang[2], Martin Palm[3], Iurii Bogomol[4], Manja Krüger[1]

[1]*Otto-von-Guericke University Magdeburg, Institute of Materials and Joining Technology, Germany*
[2]*Karlsruhe Institute of Technology, Institute for Applied Materials, Germany*
[3]*Max-Planck-Institut für Eisenforschung GmbH, Intermetallic Materials, Düsseldorf, Germany*
[4]*National Technical University of Ukraine, High Temperature Materials and Powder Metallurgy Department, Kiev, Ukraine*

Ni-based superalloys have been extensively used as high temperature materials in gas- and aircraft turbines for decades. However, they have reached their application limits at applied surface temperatures of around 1150°C due to the well-known thermal instability of the γ/γ' microstructure. Consequently, new high temperature materials must be developed to further increase the efficiency of these thermal machines like for instance turbines. The present work addresses Mo-Si-B alloys of the Mo-rich region of the phase diagram, which are located in the so-called "Berczik triangle". These alloys consist of a three-phase microstructure with a Mo solid solution phase (Mo_{SS}) and the two intermetallic phases Mo_5SiB_2 (T2) and Mo_3Si. The aim of the present study is to find the ternary eutectic composition which is expected to combine properties such as high strength and an excellent creep resistance of Mo-Si-B alloys with a well-defined microstructure. Different alloy compositions in the respective primary solidification areas of the Mo_{SS}, T2 and Mo_5Si_3 phases were chosen to investigate the microstructural evolution. The alloys were produced by arc-melting and investigated using SEM-BSE images and EPMA measurements. The results were compared to thermodynamic calculations of the liquidus projection and isopleth phase diagrams using the software FactSage™. By carrying out these experiments it was possibly to determine the ternary eutectic point, which was found to have a nominal composition of Mo-17.5Si-8B (at.%). In a next step the new ternary eutectic composition was chosen for a directionall solidification process (DS), since it is well known from the literature that eutectic compositions may result in a lamellar or fiber-matrix microstructure using DS. In agreement with the solidification pathway a ternary eutectic DS alloy Mo-17.5Si-8B could be achieved which showed well-aligned ternary eutectic colonies parallel to the growth axis. Additionally, the mechanical properties of the eutectic DS alloy at high temperatures were investigated in terms of compressive creep strength in the temperature range from 1100-1400°C. The results were evaluated and compared with a commonly used Ni-based superalloy, the arc-molten Mo-17.5Si-8B eutectic composition and a powder metallurgical (PM) processed alloy Mo-9Si-8B. The eutectic cast and DS Mo-Si-B alloys show a superior creep resistance showing great potential for applications at temperatures of around 1200-1300°C.