MM 12: Transport - High Entropy Alloys

Time: Monday 15:45–16:45 Location: IFW A

MM 12.1 Mon 15:45 IFW A

Solute and self-diffusion in HCP high entropy alloys — •Sandipan Sen[1], Mayur Vaidya[1], Lukasz Rogal[2], Xi Zhang[3], Blazej Grabowski[3,4], Sankaran Shanmugam[5], Gerhard Wilde[1], and Sergiy Divinski[1] — [1]Institute of Materials Physics, University of Münster, Wilhelm-Klemm-Str. 10, 48149 Münster, Germany — [2]Institute of Metallurgy and Materials Science of the Polish Academy of Sciences, 30-059 Krakow, Poland — [3]Max-Planck-Institut für Eisenforschung GmbH, 40237 Düsseldorf, Germany — [4]Institute of Materials Science, University of Stuttgart, 70569 Stuttgart Germany — [5]Department of Metallurgical and Materials Engineering, Indian Institute of Technology Madras, Chennai-600036, India

Diffusion studies in high entropy alloys (HEAs) are still scarce and practically limited to FCC systems. For the first time, diffusion in HCP HEAs is investigated using a radiotracer technique. Solute diffusion of Co and self-diffusion of Zr are systematically measured in binary HfZr, ternary HfZrTi, and quinary Al-Hf-Sc-Ti-Zr alloys in the temperature range of 400*C to 1100 *C. The phase composition of the alloys is characterized by X-ray diffraction and transmission electron microscopy. Two quinary systems (Al15Hf25Sc10Ti25Zr25 and Al5Hf25Sc20Ti25Zr25) are studied to examine the influence of the Al addition and potential ordering. A comparative study of the solute and self-diffusion is made to understand the impact of chemical disorder and of potential ordering on the diffusion properties in these systems.

MM 12.2 Mon 16:00 IFW A

tracer diffusion in the σ-phase of the CoCrFeMnNi system — jingfeng zhang[1], mohan muralikrishna garlapati[1,2], alex asabre[3], guillaume laplanche[3], sergiy divinski[1], and •gerhard wilde[1] — [1]Institute of Materials Physics, University of Münster, Münster, Germany — [2]Department of Metallurgical & Materials Engineering, Indian Institute of Technology Madras, Chennai, India — [3]Institut für Werkstoffe, Ruhr-Universität Bochum, Bochum, Germany

Formation of a Cr-rich σ-phase in the CoCrFeMnNi high-entropy alloy during long term exposures at intermediate temperatures ($<$ 1073 K) is detrimental for the mechanical properties. The σ-phase represents a topologically close-packed complex phase with a tetragonal structure. The diffusion processes which take place in the σ-phase are very important to understand the kinetics of precipitation of this phase in the cantor alloy. So far, there are no reports on diffusion in the σ-phase composed of elements in Cantor alloys.

In the present work, the σ-phase with the composition Co46Cr15.2Fe16.3Mn17Ni5.5 (in at.%) was produced and investigated. For the first time, tracer diffusion of Ni and Fe was measured in the temperature interval from 928 - 1173 K using 64Ni and 58Fe natural isotopes in combination with depth profiling by a secondary ion mass spectroscopy. Diffusion of both Ni and Fe in the σ-phase is found to be faster compared to that in the Cantor alloy. Various reasons influencing diffusion in the σ-phase and its effect on phase stability of the Cantor alloy system are discussed.

MM 12.3 Mon 16:15 IFW A

Radiotracer diffusion in single crystalline CoCrFeNi and CoCrFeMnNihigh entropy alloys — •Daniel Gaertner[1], Josua Kottke[1], Yury Chumlyakov[2], Gerhard Wilde[1], and Sergiy V. Divinski[1] — [1]Institute of Materials Physics, University of Münster,Münster, Germany — [2]Department of Physics of Metals, Tomsk State University, Tomsk, Russia.

High entropy alloys are multicomponent alloys, which consist of five or more elements in equiatomic or nearly equiatomic concentrations. These materials are hypothesized to show significantly decreased self-diffusivities. For the first time, the temperature dependencies of the volume diffusion rates of all constituent elements in equiatomic CoCrFeNi and CoCrFeMnNi single crystals and additionally solute diffusion of Mn an Cu in the quaternary alloy and Zn in the quinary alloy are investigated using the radiotracer technique in an extended temperature range between 923 K and 1373 K. The components are characterized by significantly different diffusion rates with the activation enthalpies in a range between 200 and 300 kJ/mol. Cu is found to be a fast diffuser at moderate temperatures below 1273 K and its diffusion rate follows the Arrhenius law with an activation enthalpy of 149 kJ/mol. Furthermore, a distinct contribution of short-circuit pipe diffusion was observed and analyzed.

MM 12.4 Mon 16:30 IFW A

Tracer diffusion in the Ni–CoCrFeMn system: transition from a dilute solid solution to a high entropy alloy — •Josua Kottke[1], Adnan Fareed[1], Shabnam Taheriniya[1], Ziyuan Rao[2], Zhiming Li[2], Mathilde Laurent-Brocq[3], Loïc Perrière[3], Łukasz Rogal[4], Harald Rösner[1], Sergiy V. Divinski[1], and Gerhard Wilde[1] — [1]Institute of Materials Physics, University of Münster, Münster, Germany — [2]Max-Planck-Institut für Eisenforschung, Düsseldorf, Germany — [3]Université Paris Est, ICMPE (UMR 7182), CNRS, UPEC, F-94320, Thiais, France — [4]Institute of Metallurgy and Materials Science of the Polish Academy of Sciences, 30-059 Krakow, Poland

High-entropy alloys, i.e. multicomponent alloys with a large number of constituting elements in equiatomic or nearly equiatomic composition, attract an increased attention as potential structural materials due to their favorable physical and mechanical properties, especially at elevated temperatures. Here, we report on the kinetic properties and the microstructural response regarding the transition from a pure metal (Ni) to a dilute solid solution and finally to a high entropy alloy within a single-phase FCC domain. Tracer diffusion rates of all elements are measured in $Co_{20}Cr_{20}Fe_{20}Mn_{20}Ni_{20}$, $Co_{10}Cr_{10}Fe_{10}Mn_{10}Ni_{60}$ and $Co_2Cr_2Fe_2Mn_2Ni_{92}$ alloys and are compared to those in pure Ni. The volume diffusion data substantiate that the proposed 'sluggish' diffusion is at least an ambiguous concept. Grain boundary diffusion shows a number of unexpected features which are related to the microstructure characteristics and have been further analyzed by TEM and APT.