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Solute diffusion of ^{64}Cu in single crystalline CoCrFeNi HEA

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High entropy alloys are multicomponent alloys, which consist of four or more elements in equiatomic or nearly equiatomic concentrations. These materials are hypothesized to show significantly decreased self-diffusivities. The understanding of the diffusion kinetics in HEAs is of fundamental significance, however the present knowledge is limited to several interdiffusion investigations on the one hand and the direct radiotracer measurements in single and polycrystalline CoCrFeNi and CoCrFeMnNi on the other hand. Recent studies were mainly focused on the radiotracer self-diffusion of the constituent elements in CoCrFeNi and CoCrFeMnNi. Further alloying the CoCrFeNi alloy with Cu in equiatomic proportion to the quinary CoCrCuFeNi HEA and additionally Al to the AlCoCrCuFeNi HEA, the knowledge of the Cu solute diffusion in the quaternary alloy is mandatory. The here presented results of copper diffusion were obtained on single crystalline CoCrFeNi HEAs utilizing the on-line diffusion chamber located at the ISOLDE facility in off-line mode. The CoCrFeNi HEA was implanted with ^{64}Cu at the ISOLDE/CERN radioactive ion-beam facility. Afterwards, isothermal annealing was performed in a temperature range from 973-1173 K followed by serial sectioning via ion-beam sputtering and recording of the corresponding γ-spectra of each section using a NaI-detector. The diffusion coefficients, derived from the obtained tracer penetration depth profiles, can be well described by the Arrhenius equation with an activation energy of 149 kJ/mol and a pre-exponential factor of 6.6×10^{-10} $m^2\ s^{-1}$. This is comparable faster than the ^{57}Co, ^{51}Cr, ^{59}Fe and ^{54}Mn diffusivities in the same HEA with an activation enthalpy which is half of the activation enthalpies of the constituents.

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