Characterization of the formation of single-phase precious metal high entropy alloys by in situ diffraction

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High entropy alloys (HEA) have attracted considerable attention as it is thought that their chemical complexity may allow the synthesis of materials with desirable properties [1,2]. According to one often-used definition, HEAs contain five or more elements with concentrations between 5 and 35 at.-% [1,2]. A little investigated group of HEAs are the precious metal HEAs, which contain at least four Elements out of Ag, Au, Co, Cr, Cu, Ni, Pd, Pt, Rh and Ru [2], and which have been studied here.

While most HEAs are synthesized either by arc melting or mechanochemical activation, we have shown earlier that the combination of precious metals with Sn as a fifth element, a low melting component (T_M = 505 K), leads to the formation of single phase HEAs at comparatively low temperatures [3]. Here, we have investigated the formation of HEAs such as $Pt_2AuCuNiSn$ by *in situ* powder diffraction at the high energy beamline P21.1 at PETRA III (DESY, Hamburg). We pressed the elements into pellets with 2 mm diameter. These were then heated with a heating rate of 6 K/min up to 1460 K. The reaction was observed by powder X-ray diffraction, which allowed us to identify the on-set of reactions, the formation of transient phases during heating and cooling, and to characterize the final products. A typical set of diffraction patterns is shown in Fig. 1, where the disappearance of Sn can be observed at ~500 K, while the formation of the final product commences at ~800 K.

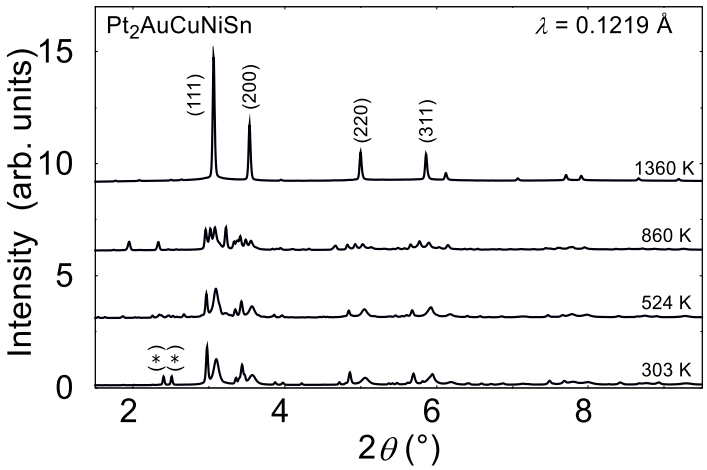

Fig. 1: Powder X-ray diffraction of $Pt_2AuCuNiSn$ while heating. Reflections of $Pt_2AuCuNiSn$ are indexed at the highest temperature, they can be identified at T > 800 K. Reflections due to Sn (∗) can only be observed up to ~500 K.

Most data sets could be analyzed by Rietveld refinement, and hence we could show that we have synthesized new single precious metal phase HEAs in the system Pt-Pd-Cu-Ni-Co-Au-Ag-Sn.

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