MS26-03 | Nucleation and Growth of Tenfold Twins of NiZr during Non-Equilibrium Solidification

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Understanding the solidification of metals and alloys is of utmost importance in metallurgy and materials science, since it ideally allows for a purposeful microstructure design, which itself is governing the properties of a technologically used material. However, while some metallic systems are well-understood in this sense, this is not true in general. In particular, for many alloys crystal structures are as complex as microstructures and the interplay between both levels of structural hierarchy appears as mostly uncharted territory.

Here, we report on the homogeneous nucleation of a single quasicrystalline seed from the undercooled melt of glass-forming NiZr and its continuous growth into a tenfold twinned dendritic microstructure. Observing a series of crystallization events on electrostatically levitated NiZr confirms homogeneous nucleation. Mapping the microstructure with electron backscatter diffraction suggests a unique, distortion-free structure merging a common structure type of binary alloys with a spiral growth mechanism resembling phyllotaxis. A general geometric description, relating all atomic loci, observed by atomic resolution electron microscopy, to a pentagonal Z module, explains how the seed's decagonal long-range orientational order is conserved throughout the symmetry breaking steps of twinning and dendritic growth.