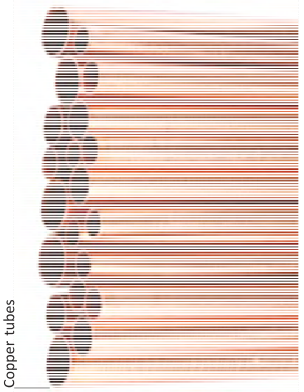
High pressure torsion effects in Al-Cu metastable alloy at nm scale can be observed in orientation maps

Metals under Huge Stress



Silver and copper have a wide miscibility gap therefore special methodologies are needed to obtain a metastable alloy. The usual results of a Cu-Ag alloy synthesis is spinodal decomposition of Ag, Cu phases intergrown in bands some hundred nanometers wide. A way to push the spinodal decomposition to a smaller scale is given by the severe plastic deformation induced by a high pressure torsion (HPT).

Several cycles of HPT mixed together the Ag and Cu bands in smaller grains of an Ag-Cu alloy. This process is extremely difficult to map in terms of phase separation, grain size and crystal orientation since it occurs on a nanometer scale.

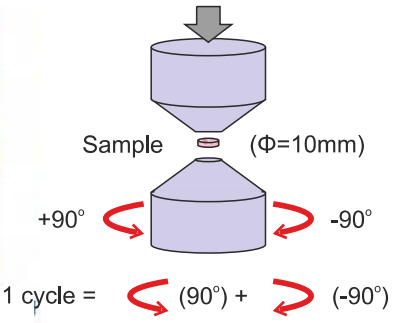
The ASTAR technique can follow the processes in all phases. In the as cast starting mixture, an alternating sequence of Ag and Cu lamellae are detected. The orientation mapping reveals a strong orientation correlation between the lamellae. After one cycle of HPT the lamellar structure is hardly recognizable in planar view and becomes thinner and irregular in sections tangential to the deformation cylinder. The deformation induced by the torsion also changes the grain size and the texturing.

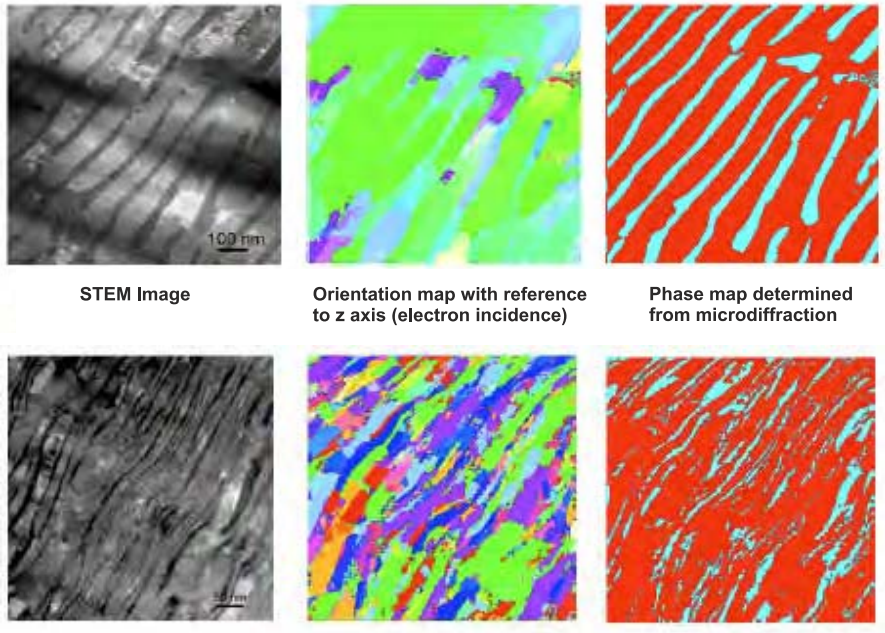
The challenge:	Identify orientation / phase of 2 different phases particles with < 50 nm
Solution:	ASTAR technique

Within each lamella some small grains with irregular shape start to appear. The orientation correlation between the lamellae is strongly reduced.

The process can be characterized with ASTAR at each step until a complete alloy is formed after 10 HPT cycles.

Schematic Illustration of HPT process





Crystal Structure

Silver: cubic, a = 4.086 Å
Copper: cubic, a = 3.615 Å

Experimental Data

TEM type: Tecnai F20 ST
Map resolution: 4 nm
Scanned area: 800 x 800 nm

figure 1

Top: The $Ag_{60}Cu_{40}$ eutectic mixture as cast.A regular spinoidal decomposition into Ag and Cu phase is easily detected by ASTAR.

Bottom: The same sample after one high pressure torsion treatment in tangential view. The spinodal decomposition bands become thinner and less corrected.

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