Experimental report

13/09/2023

Proposal: DIR-263 **Council:** 10/2022

Title: Study of deformation mechanisms inAlFeCoCrNi High-Entropy alloy: Competition between dislocation slip and twinning

Research area: Engineering

This proposal is a new proposal

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Samples: Al5Fe30Co25Cr15Ni25 alloy

Instrument	Requested days	Allocated days	From	To
SALSA	4	4	30/08/2023	06/09/2023

Abstract:

The aim of the present proposal is to carry out neutron diffraction (ND) experiments during in-situ compression tests in a Al5Fe30Co25Cr15Ni25 alloy with several microstructures which depend on the processing route: cold rolling and recrystallization treatments or hot-rolling. The evolution of the internal elastic strains of the different diffraction peaks allows to discriminate the different deformation mechanisms that take place during plastic deformation.

DIR-263. Study of deformation mechanisms inAlFeCoCrNi High-Entropy alloy: Competition between dislocation slip and twinning

The deformation mechanism of the high entropy Al5Fe30Co25Cr15Ni25 alloy processed by two different routes: cold rolling and cold rolling and thermal treatment at 700 ºC for 1 hour was studied by neutron diffraction during in-situ compression tests at SALSA. The microstructure of the CR conditions is characterized by elongated grains along the rolling direction. On the other hand, after the thermal treatment at high temperature, the microstructure is fully recrystallized (Figure 1b)

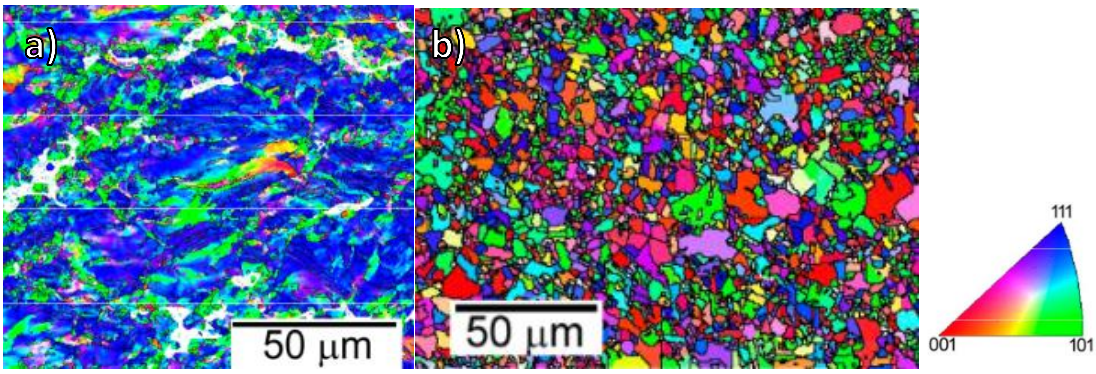

Fig 1 (a,b). Microstructure of the a) CR and b) CR+700ºC(1h) alloys.

Compression samples were cylinders of 3.5 mm of diameter and 7 mm of length. The gauge volume defined by the primary and secondary radial collimators was 0.6x0.6x2 mm^3 and was positioned in the center of the compression sample. The tensile rig 15kN is mounted in a cradle that allows to rotate the same from the axial to the radial direction (0-90º).

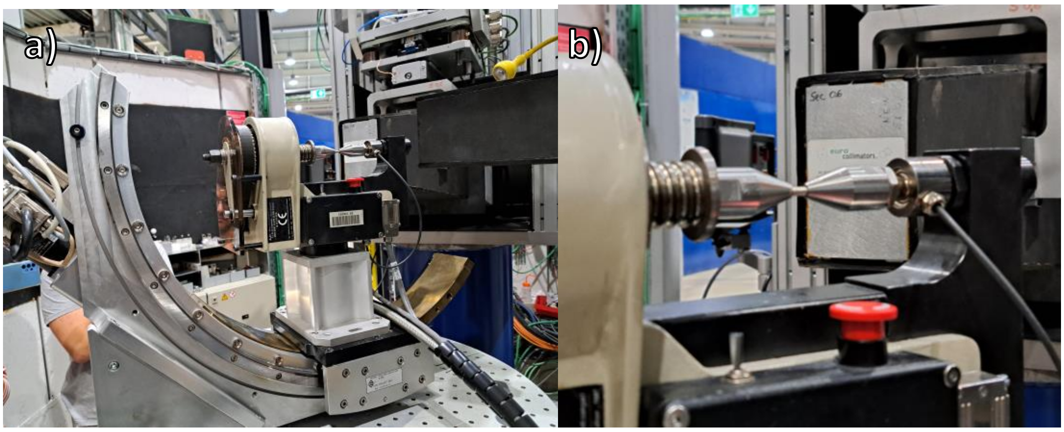

Fig 2 (a,b). Set up of the compression test of HEAs in the beamline SALSA

The diffraction peaks corresponding to the (111), (200), (220) and (113) planes parallel and perpendicular to the compression axis were recorded independently at different stress steps that cover the complete compression test. In the elastic regime, a sin^2psi was selected to obtain also the elastic constants. However, the linear behavior is only observed in the case of the (113) diffraction peak.

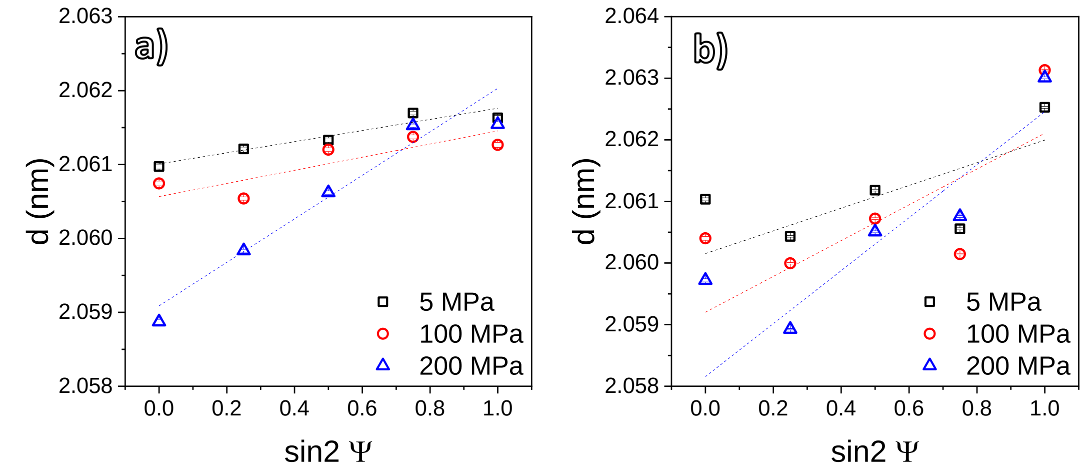

Fig 3 (a,b). $\sin^2 \Psi$ plot for both processing routes in the case of the (111) diffraction peak: a) CR and b) CR+700ºC(1h).

Figure 1 shows the evolution of internal strains as a function of the applied stress in the axial and radial direction for both processing conditions. This evolution is different for each diffraction peak and reflect the different elastic-plastic behavior of grains depending on the crystallographic orientation. The deformation in both cases is controlled by the activation of slip of dislocation [110]-type on the {111} planes. The macroscopic yield stress of the alloy measured in the tensile rig of SALSA is smaller compared to our laboratory (macroscopic) measurement in our institute. We have observed that the sample is not only compressed but also sheared. This fact should be corrected for future measurement. Grains oriented with the (200) planes perpendicular to the compression axis are stronger and behave as a reinforcement.

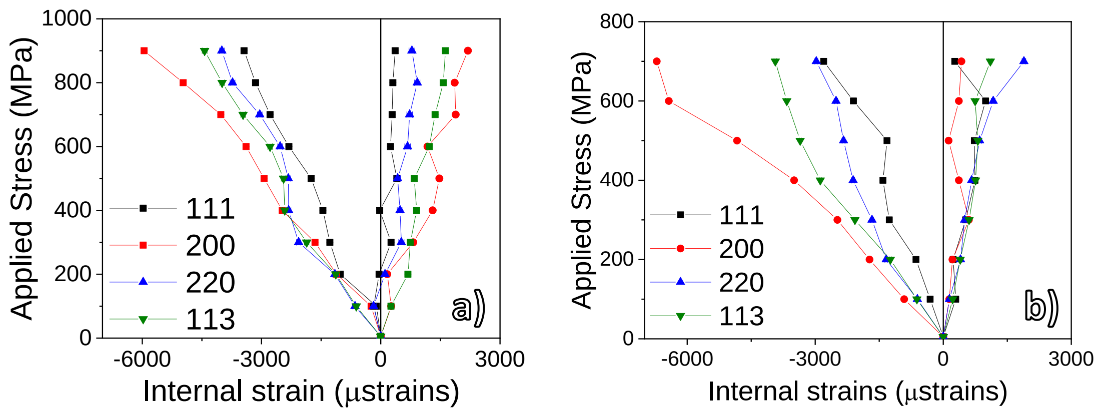

Fig 4 (a,b). Evolution of internal strain for (111), (200), (220) and (113) diffraction peaks for the a) CR and b) CR+700ºC(1h).

It is interesting to point that the system that control the tensile rig is not correctly connected to nomad and this fact delay the start of our measurement. Moreover, the correct acquisition of force and displacement was not reached.