Role of SFE on deformation texture evolution in non-equiatomic fcc CrFeMnCoNi high-entropy alloys

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Contents

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Introduction

The equiatomic CrMnFeCoNi quinary alloy is one of the most investigated HEA system so far.

- **SFE (20-25 mJ/m^2) [1-2]**
- **Mechanical nano-twinning**

A series of non-equiatomic CrMnFeCoNi HEAs with varying elemental concentration was designed to lower the SFE [3-5].

By lowering the SFE the TWIP and TRIP effect have been observed [6-9]

Motivation

Very few single phase fcc HEAs have been studied to understand the micro-mechanisms of deformation with respect to microstructure and texture evolution.

A weak brass-type texture is observed in CrFeMnCoNi HEA after 90% rolling [10].

Haase et al. reported a transition from copper-type to the brass-type texture at 50% CR reduction [11].

Tazuddin et al. observed brass-type texture evolution without formation of deformation twins in CuFeMnCoNi HEA [12]

Objective

Comprehensive understanding of the microstructure and texture evolution in these fcc HEAs

Investigation of the micro-mechanisms of deformation of non-equiatomic fcc HEAs as a function of SFE, processing temperature and imposed strain level

Study the role of slip, twinning and shear banding on texture evolution during deformation as a function of SFE and processing temperature

Non-equiatomic HEAs investigated

Alloy	**Designation**	**SFE (mJ/m²)**	**Reference**
$Ni_{26}Fe_{20}Cr_{14}Co_{20}Mn_{20}$	HEA-1	57	Zaddach et al. [4]
$Ni_{25}Fe_{20}Cr_{20}Co_{15}Mn_{20}$	HEA-2	38	Liu et al.[5]
$Ni_{18.5}Fe_{18.5}Cr_{18.5}Co_{36}Mn_{18.5}$	HEA-3	10	Zaddach et al. [4]

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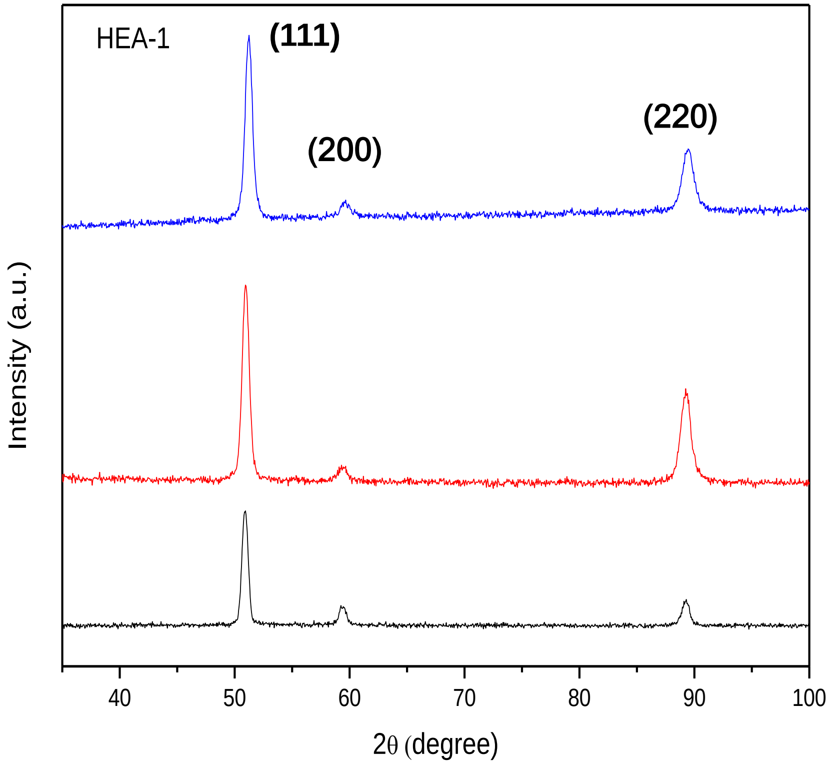
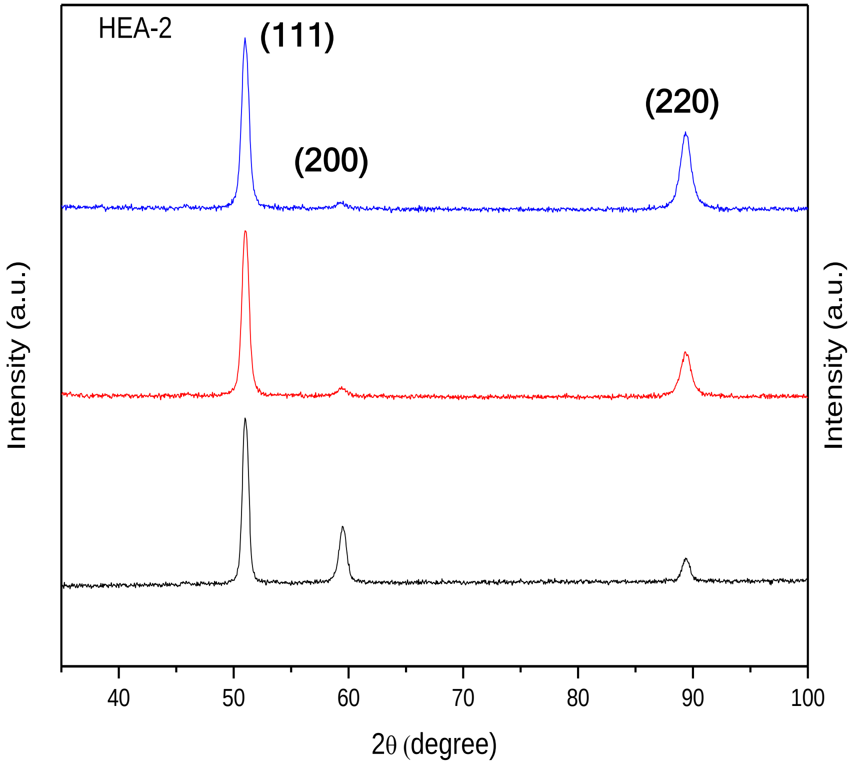
Diffractograms

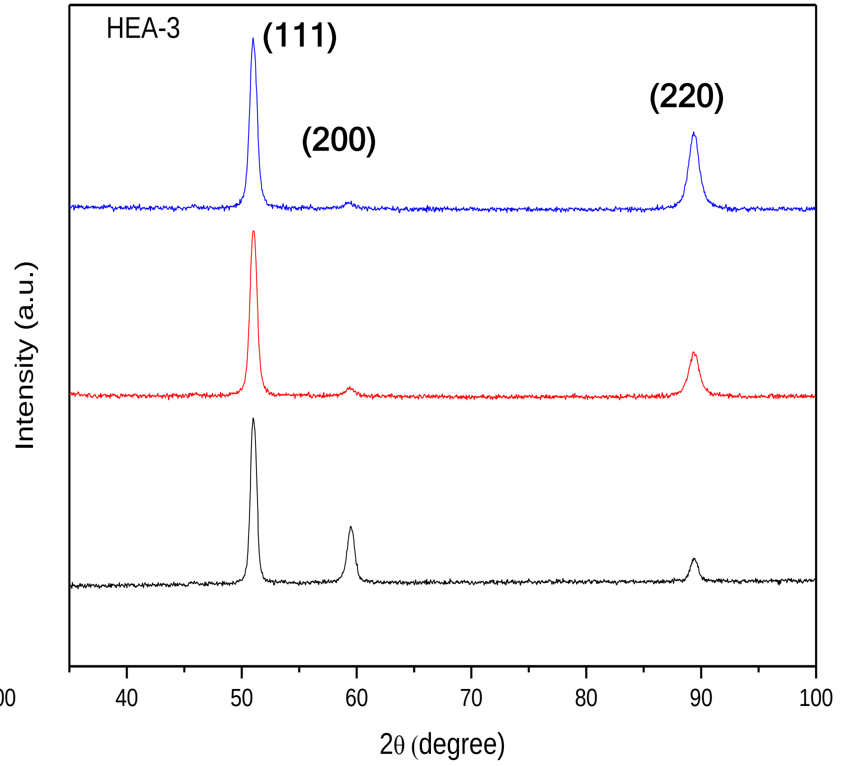
HEA-1



HEA-2



HEA-3

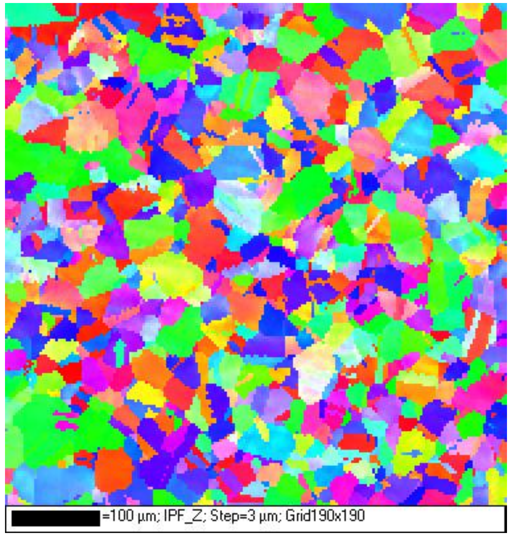


Black lines : Starting HEAs
Red lines : 90% Cold-rolled HEAs
Blue lines : 90% Cryo-rolled HEAs

Starting microstructure and texture

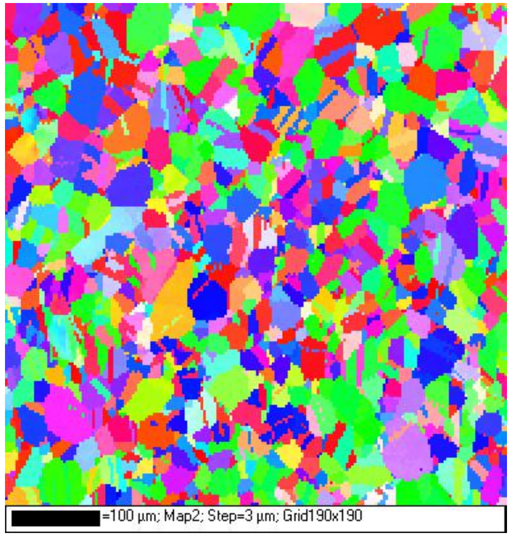
RD
ND

HEA-1



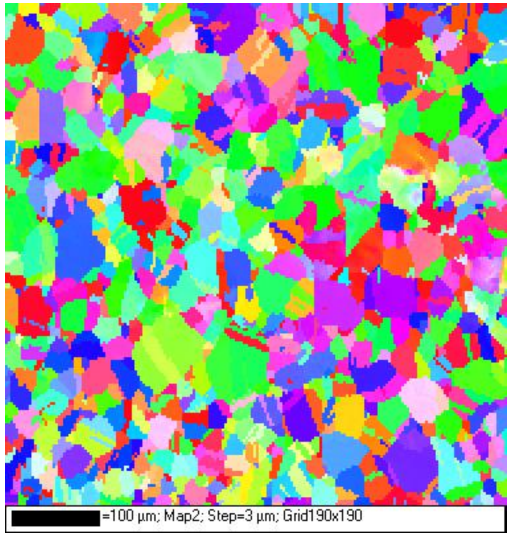
Mean Grain Size 21 µm

HEA-2

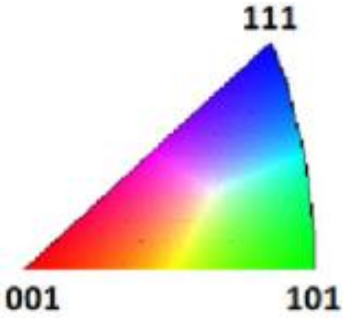


Mean Grain Size 23 µm

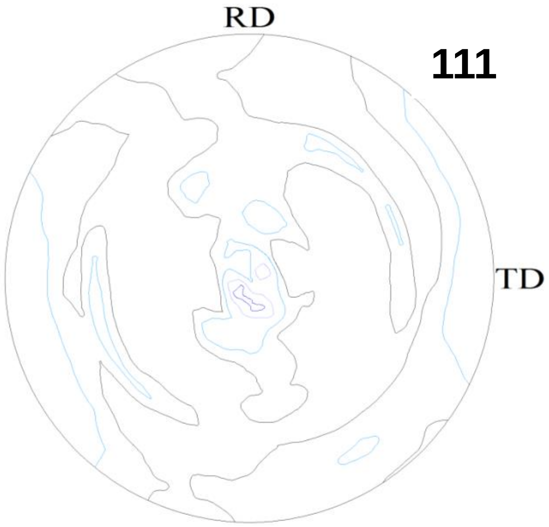
HEA-3

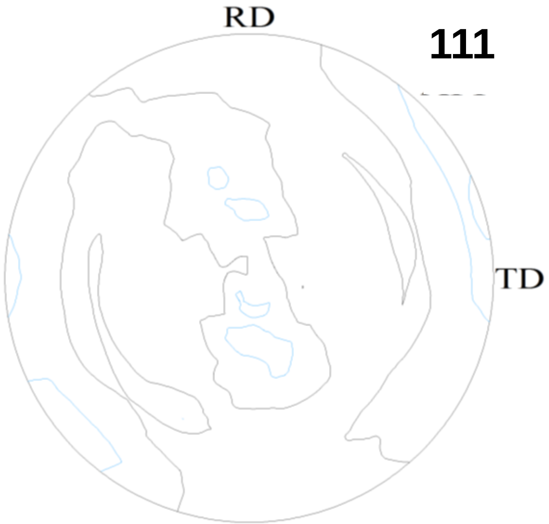


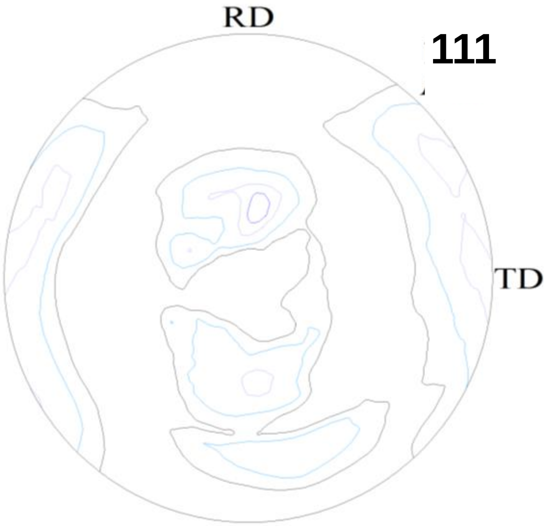
Mean Grain Size 20 µm

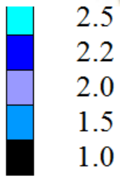


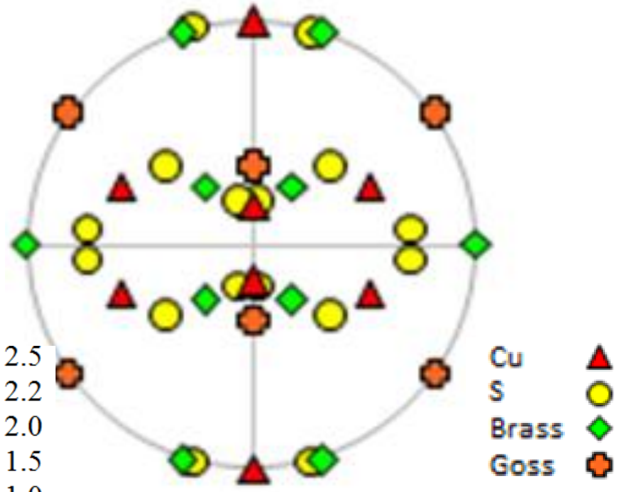
Pole figures





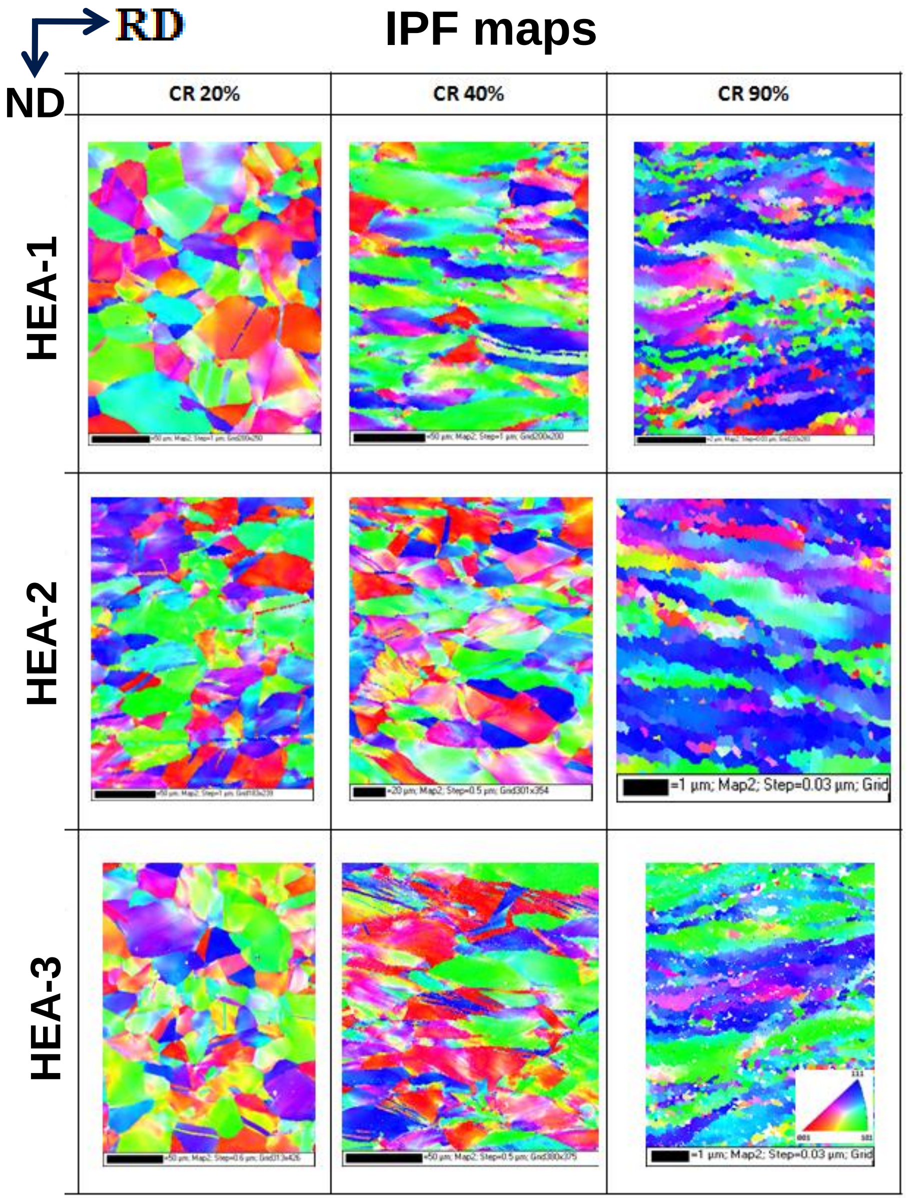




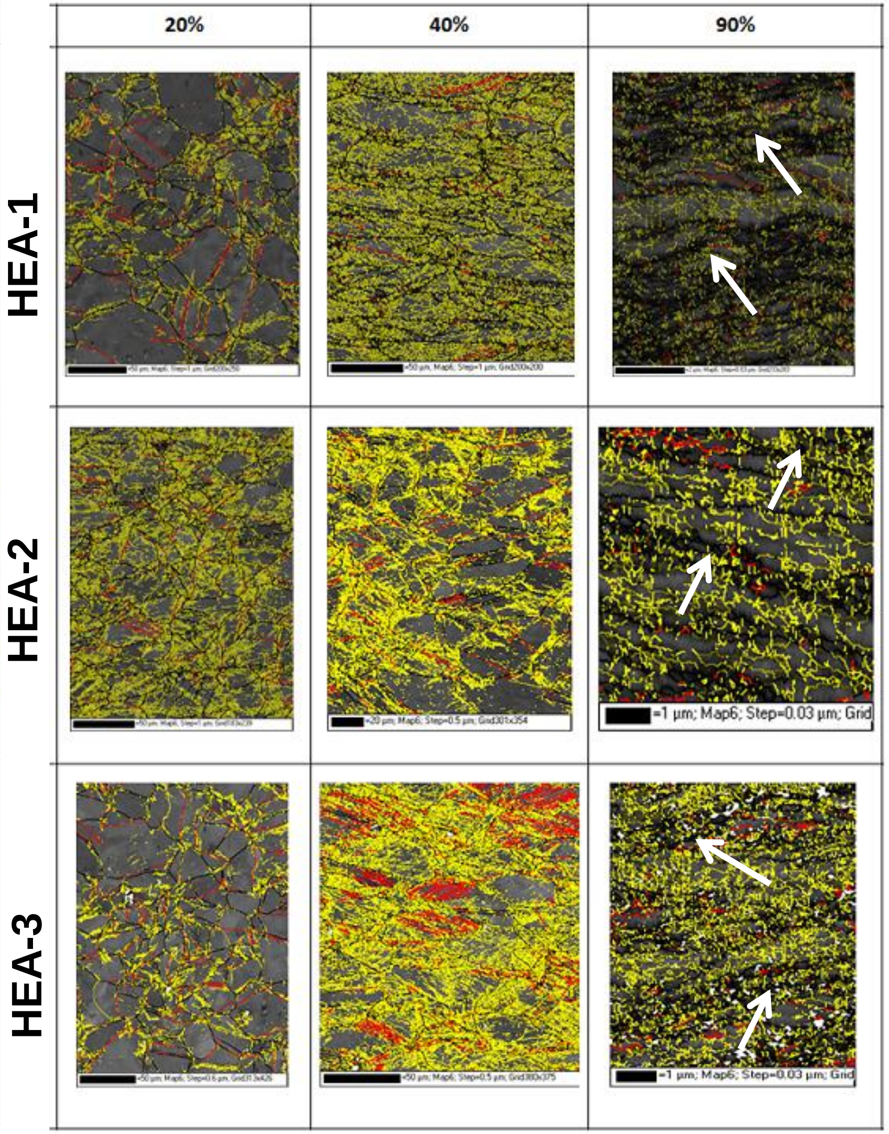


Cold-rolling microstructure

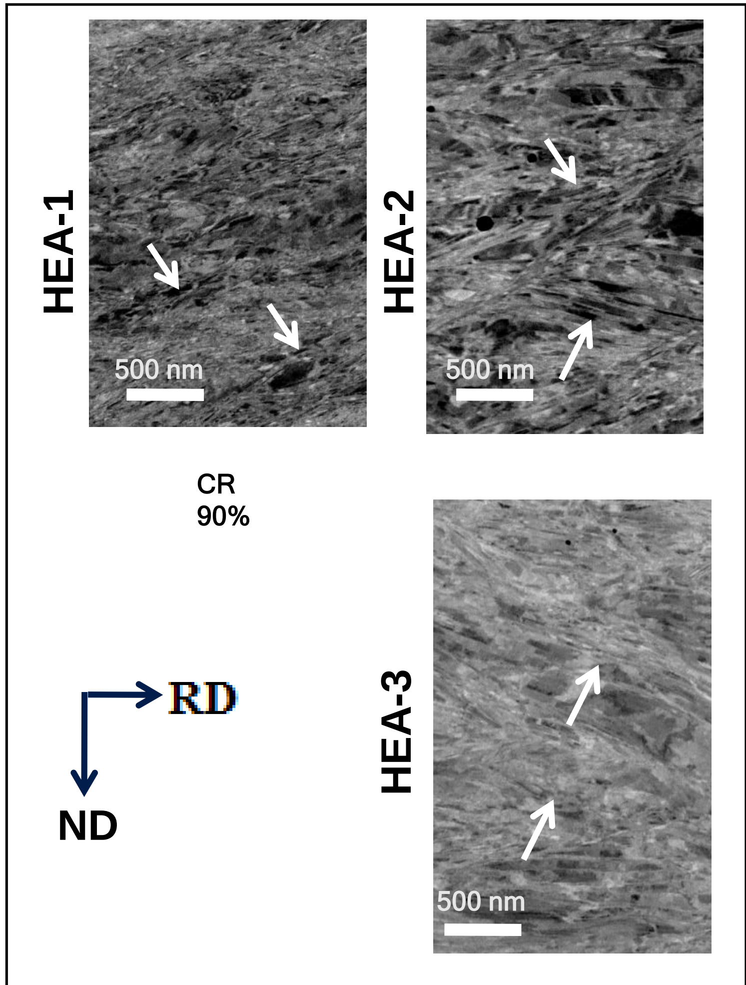
IPF maps



Grain boundary maps



BSE images



Arrows mark shear bands

Yellow lines: LAGBs (>2-15°)
Black lines : HAGBs (>15°)
Red lines : 60° <111>

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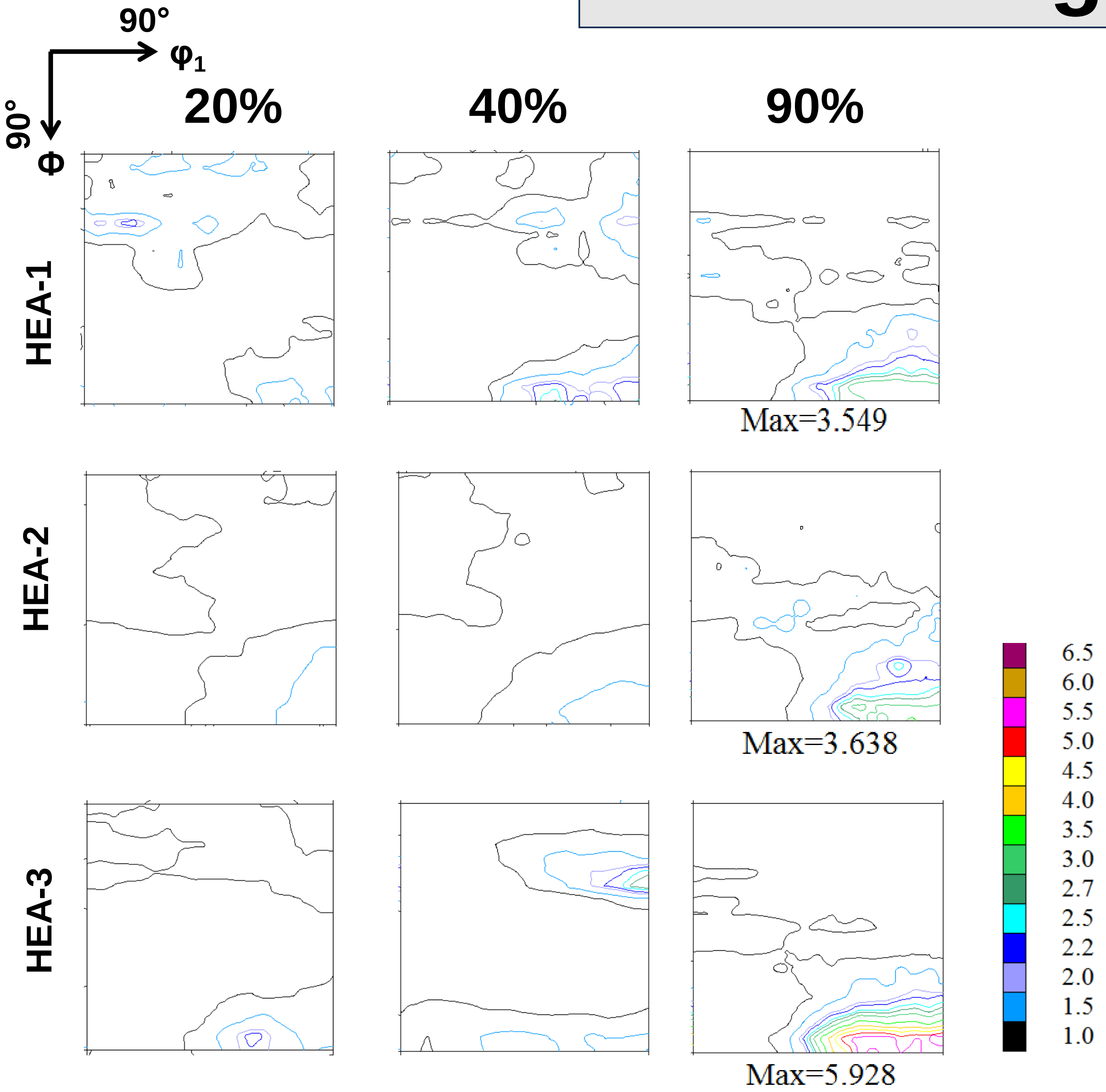
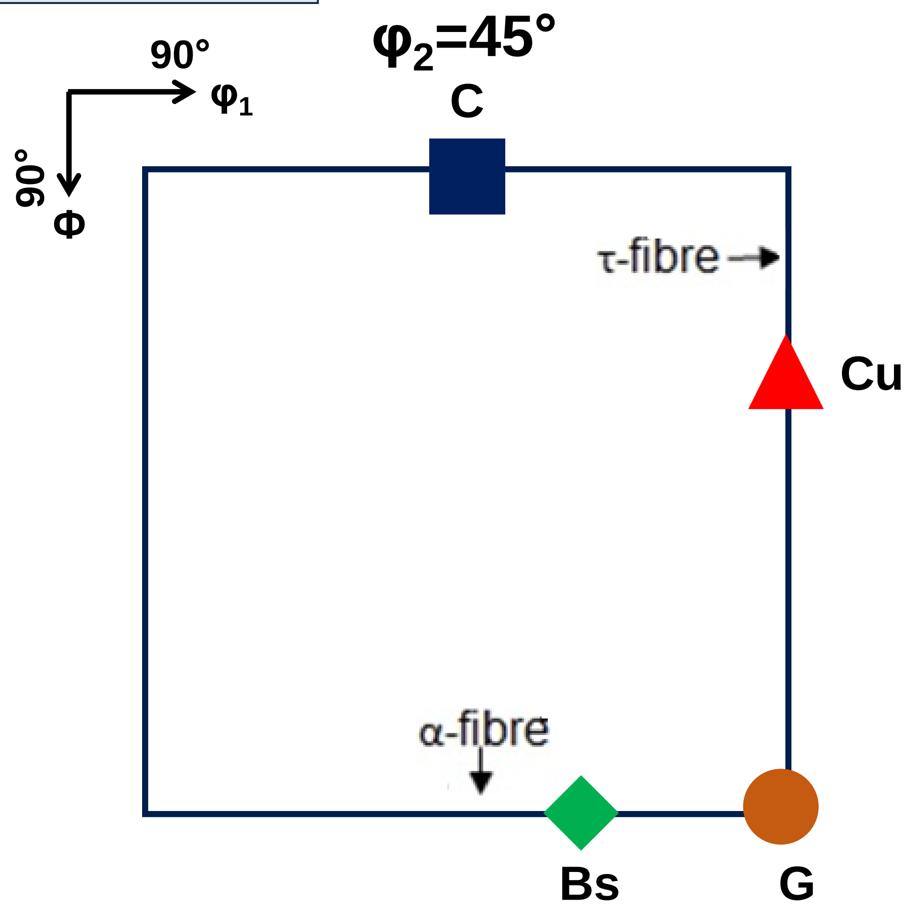
Cold-rolling texture

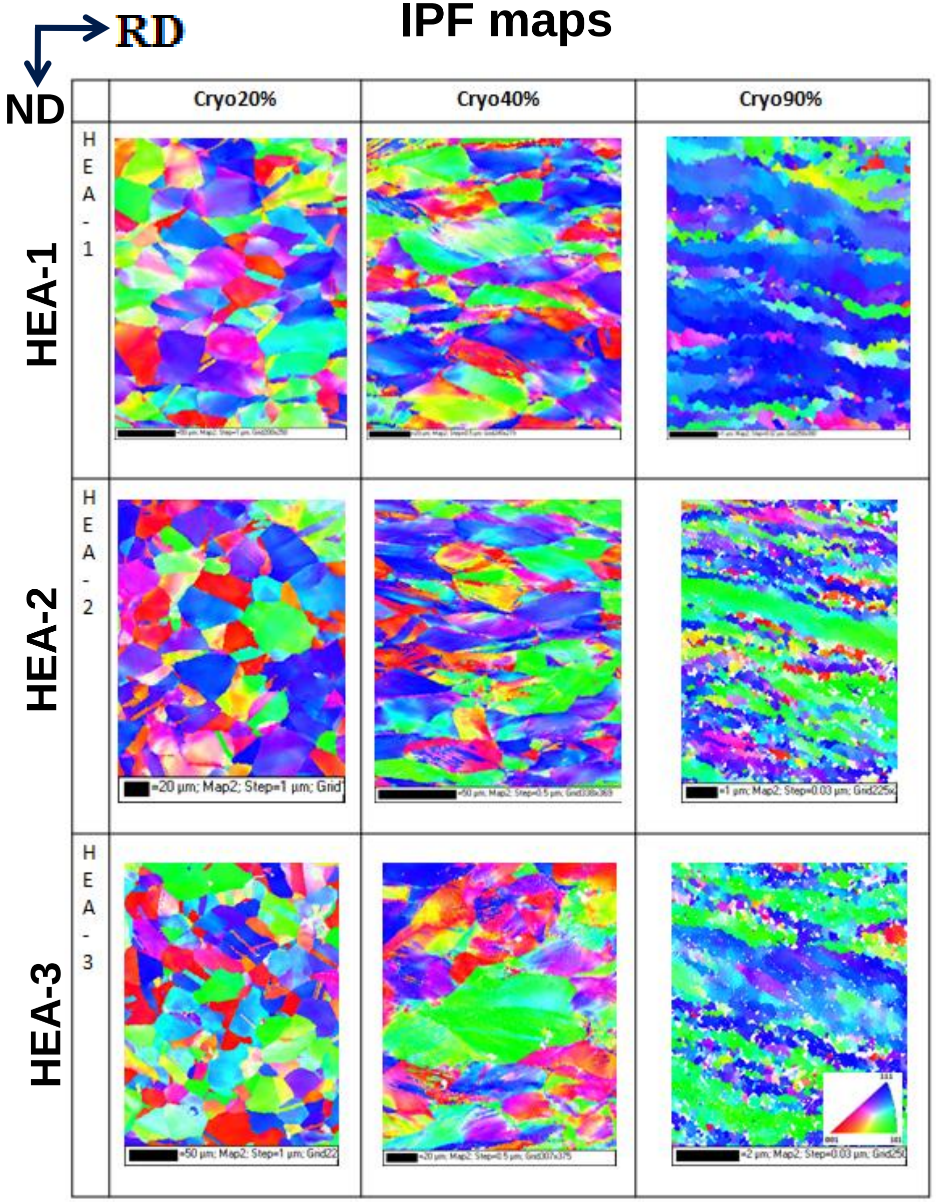




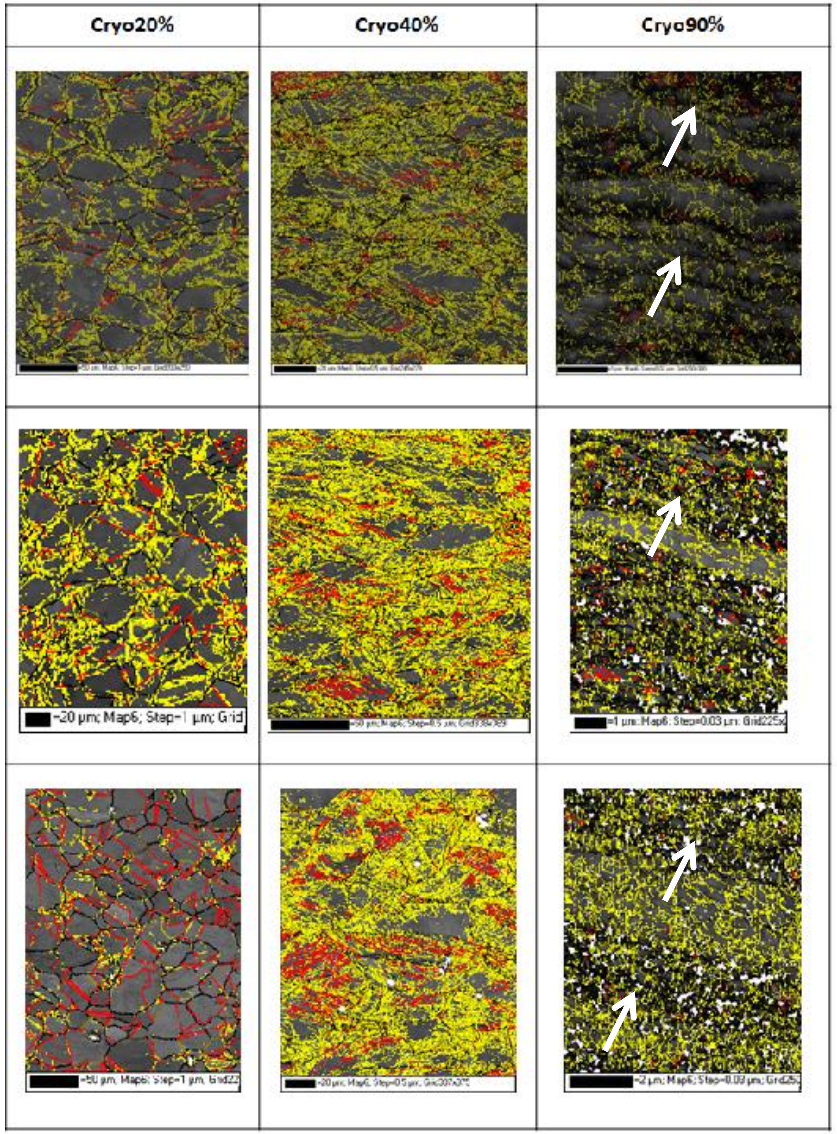
	Miller indices
Cube (C)	{001}<100>
Copper (Cu)	{112}<111>
Goss (G)	{110}<001>
Brass (Bs)	{110}<112>

Cryo-rolling microstructure

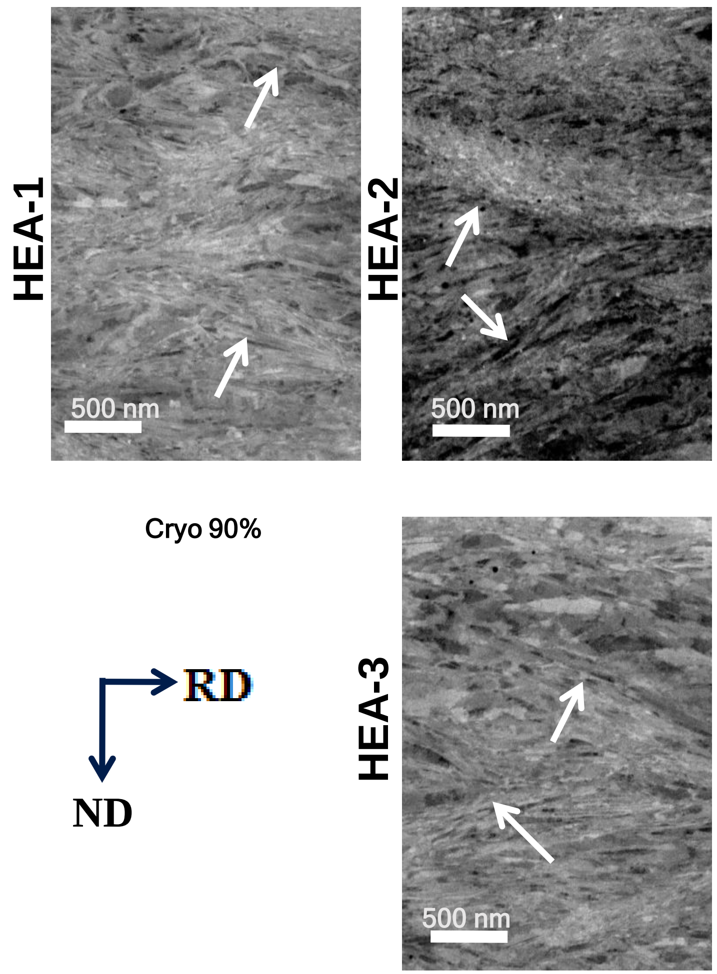
IPF maps



Grain boundary maps



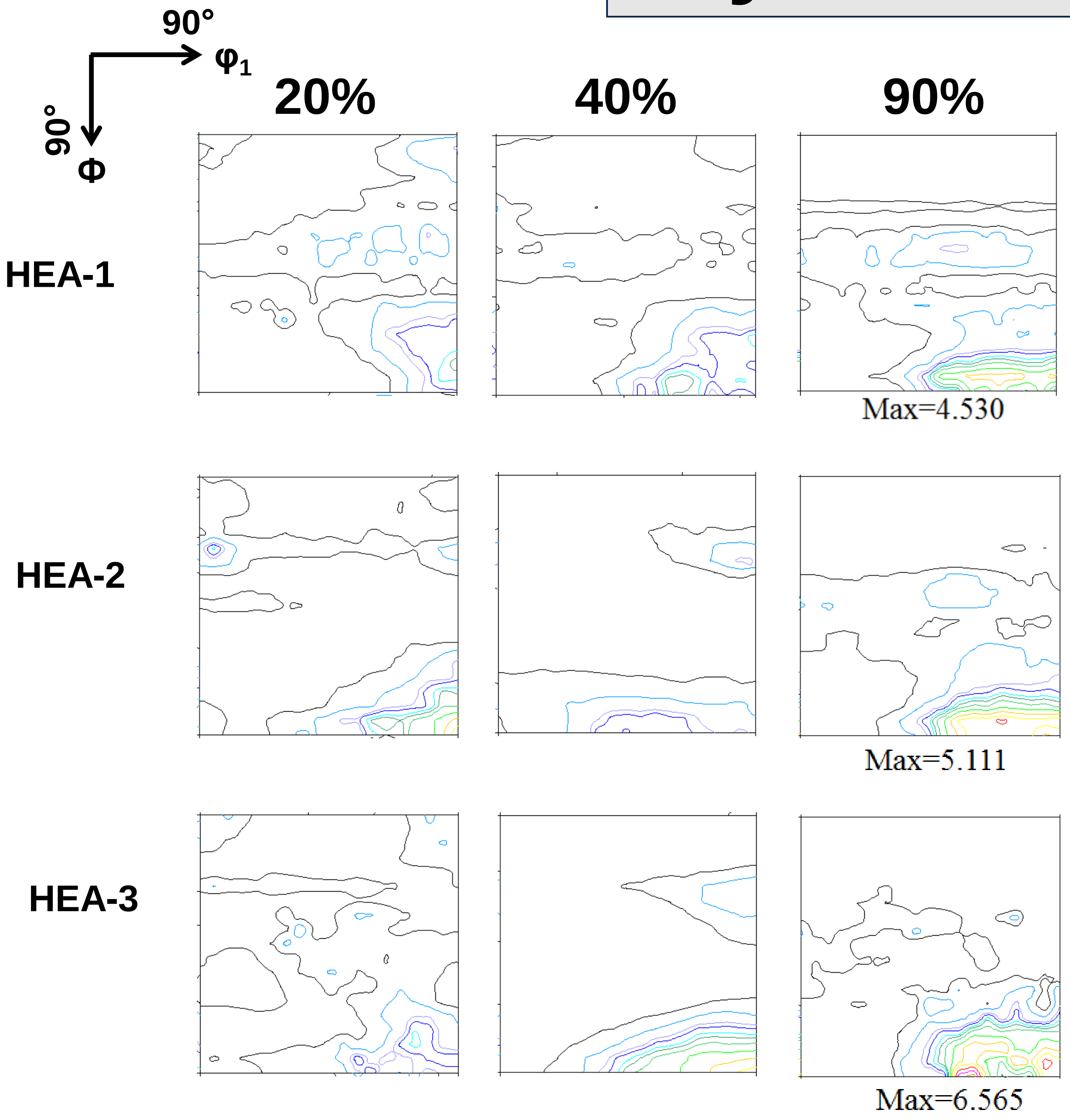
BSE images

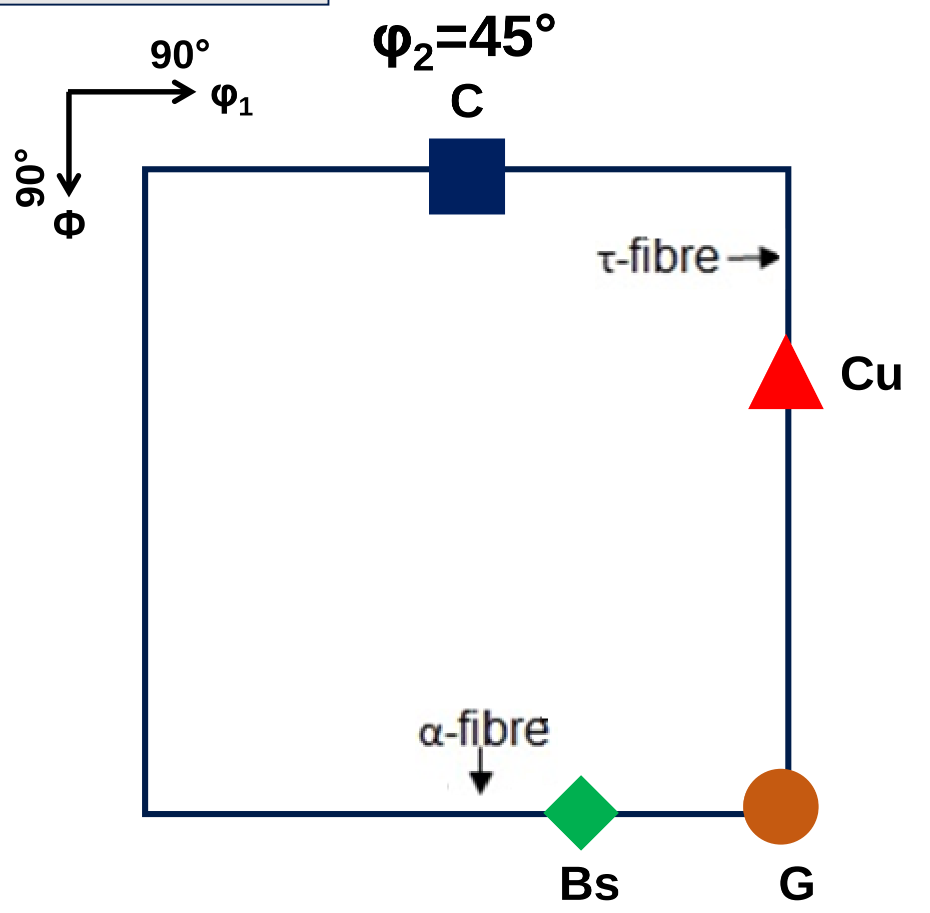


Arrows mark shear bands

Yellow lines: LAGBs (>2-15°)
Black lines : HAGBs (>15°)
Red lines : 60° <111>

Cryo-rolling texture



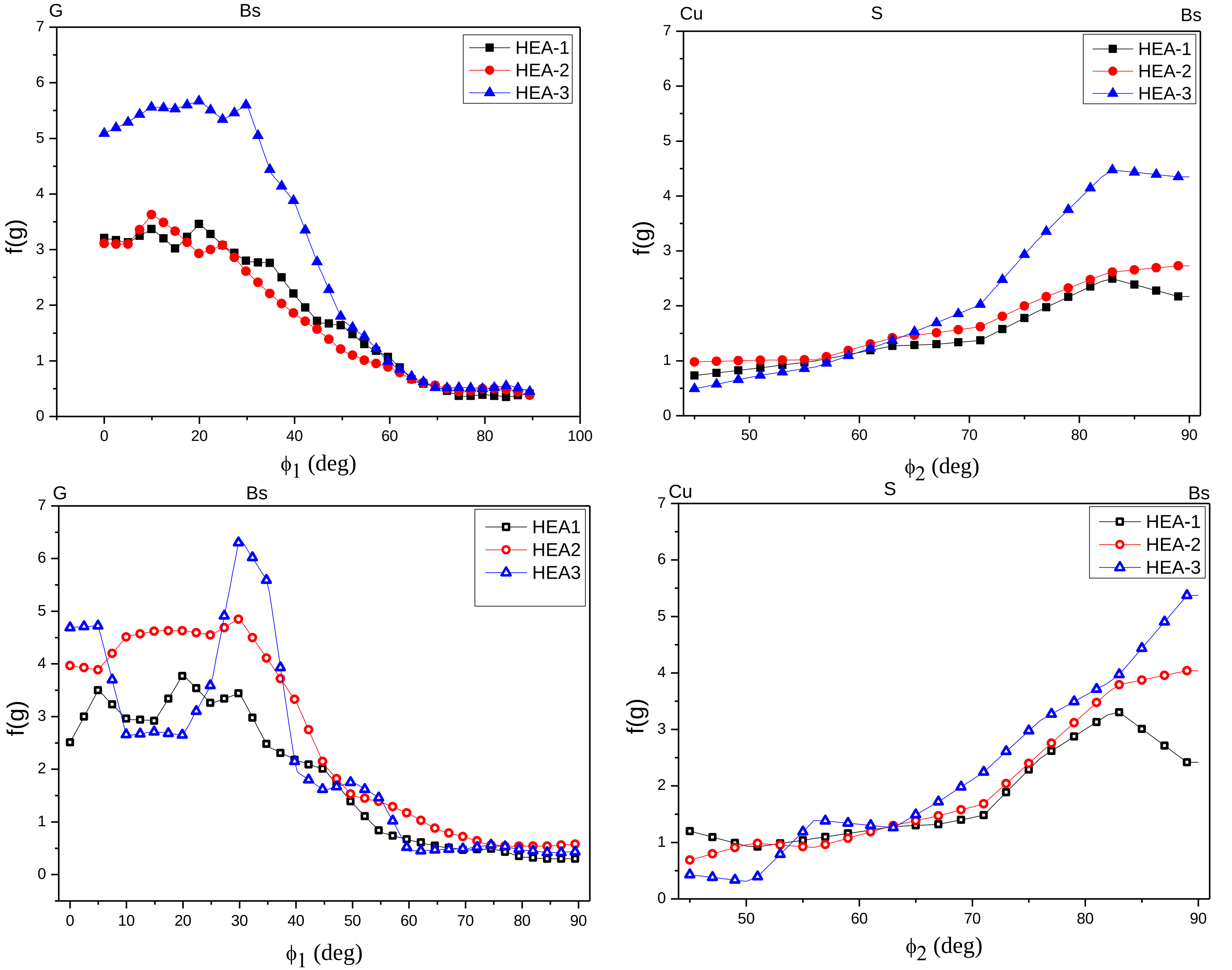


	Miller Indices
Cube (C)	{001}<100>
Copper (Cu)	{112}<111>
Goss (G)	{110}<001>
Brass (Bs)	{110}<112>

α - fibre | **β - fibre**

Cold-rolled 90%

Cryo-rolled 90%



Summary and conclusions

All HEAs develop a heterogeneous microstructure with fine-scale shear bands after 90% CR.
The texture is of brass-type both at room and cryogenic temperature.

The deformation mechanisms are dislocation slip in the early stage of rolling and deformation twinning at intermediate stage followed by shear banding in the final stage.

The intensity of the brass-type texture is related to deformation twinning and shear banding the activity of which is increasing with lowering the SFE.

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Acknowledgments

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Thanks for your attention
Queries ?