

# Investigation of an alternative path for SRF cavity fabrication and surface processing

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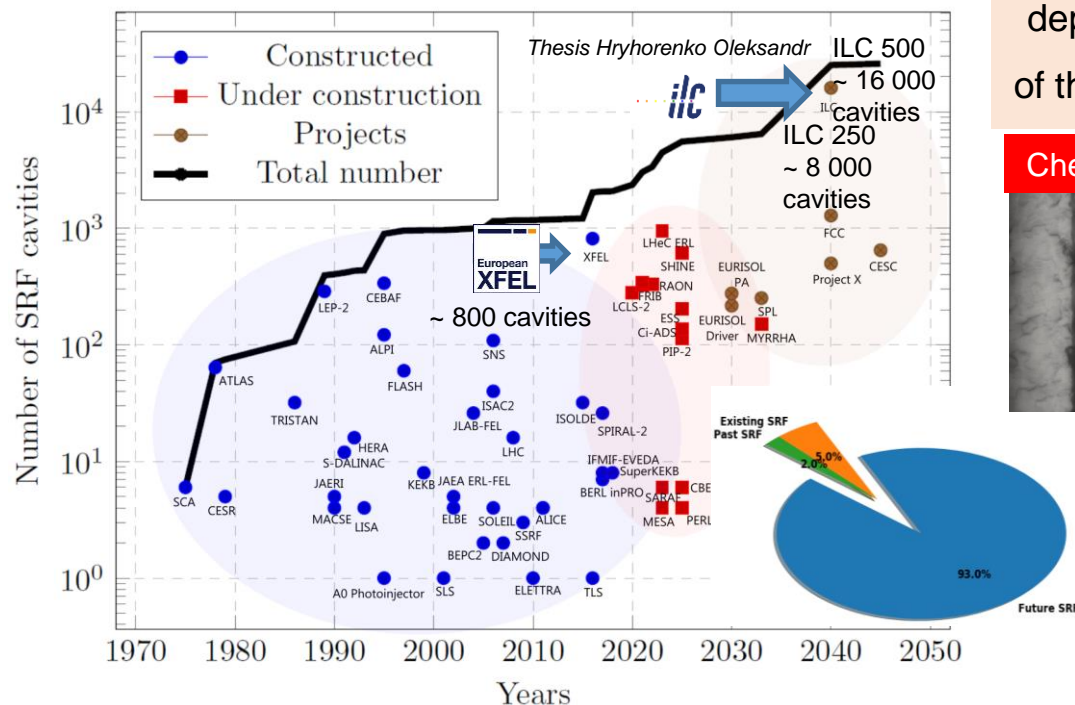
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- Motivation for an alternative path of SRF cavity fabrication and surface processing
- Jumping from flat to curved shapes
  - Forming activities on samples
  - Roughness characterization
  - Damage evaluation
- Conclusion and perspective

Possible reduction of the cost of cavity surface processing for future accelerators (replace standard chemical treatment).

Achieve better surface roughness to improve the performance (removal of all type of defects, substrate preparation for thin film deposition) => possible reduction of the cost of accelerator operation

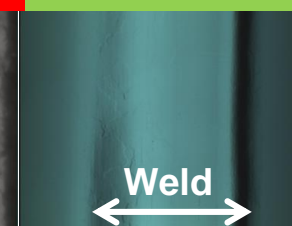
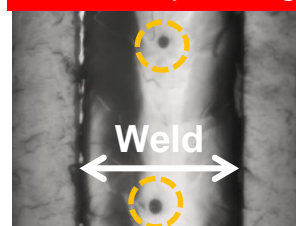
Improve environmental footprint and worker safety (remove or at least reduce the amount of used acids)



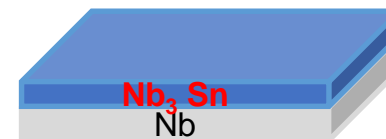
<https://tel.archives-ouvertes.fr/tel-02455975>

Chemical polishing

Mechanical-chemical



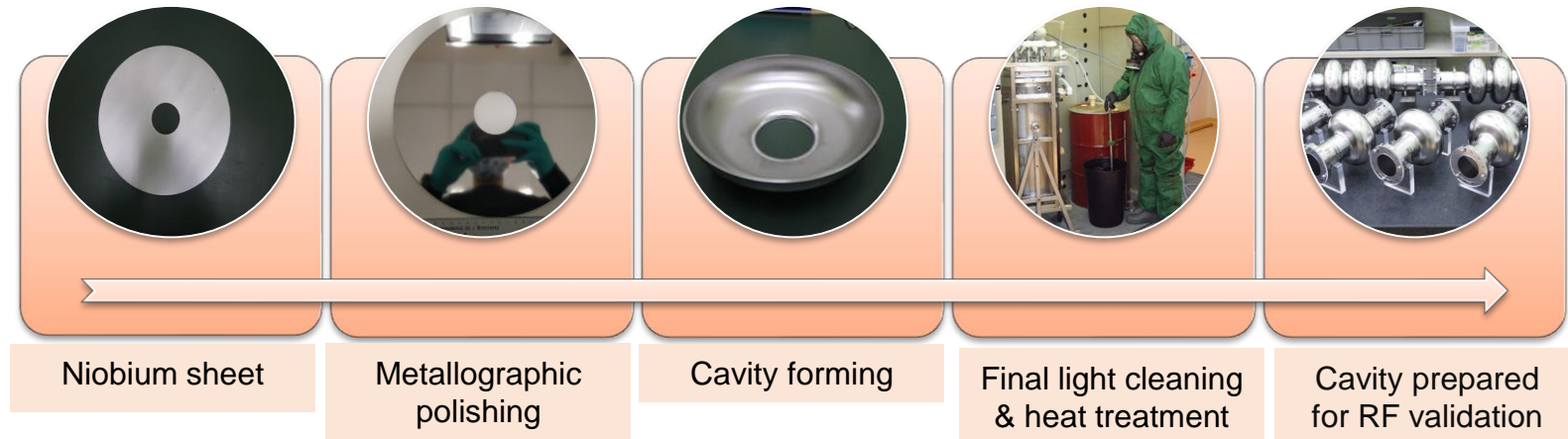
[A.D. Palczewski et al. "R&D Progress in SRF Surface Preparation With Centrifugal Barrel Polishing \(CBP\) for both Nb and Cu", in Proc. 16th Int. Conf. RF Superconductivity \(SRF'13\), Paris, France, Sep. 2013, paper TUIOB01, pp. 398-403.](#)



## Standard path :



## Alternative path :

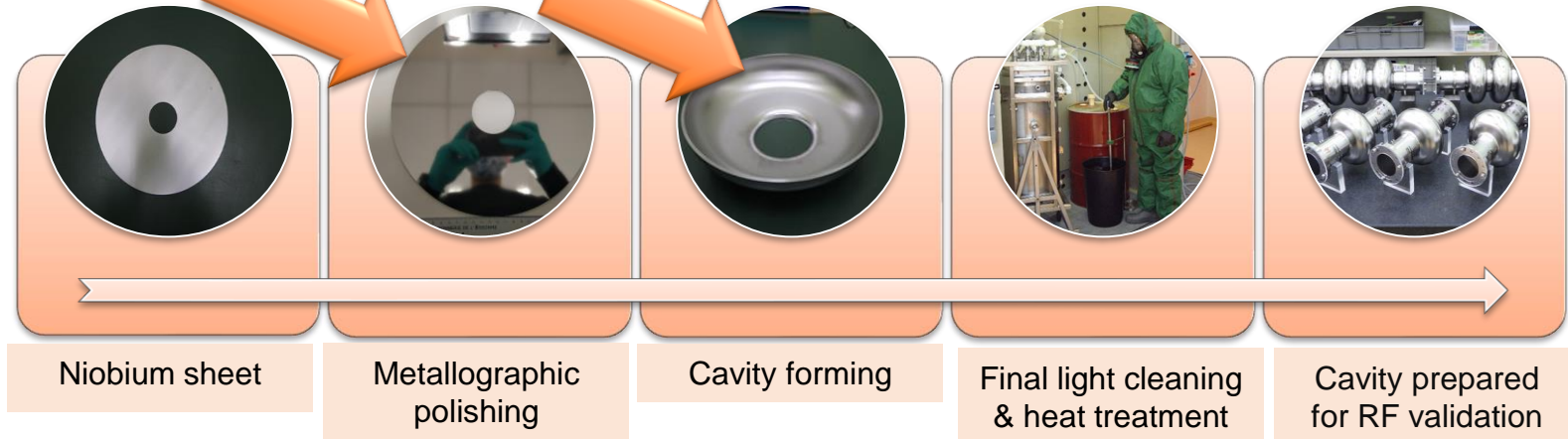


# Alternative path for SRF cavity fabrication.

## Standard path :



## Alternative path :





## Motivation

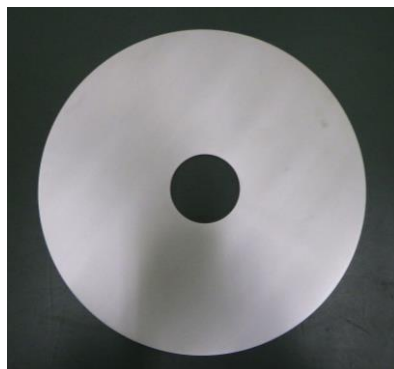
Perform metallographic polishing of Niobium disks @ **IJCLab** for cavity material to achieve higher performance.



Optimize forming technique @ **KEK** to minimize surface damages during forming process.

### IJCLab/IRFU

1. Perform Metallographic polishing of samples and disks



3. Characterization (roughness, XRD, EBSD, ...)

### KEK

2. Forming & optimization
  - forming speed
  - absorber
  - lubricant
  - etc.



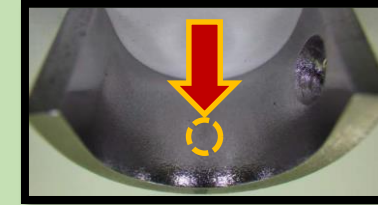
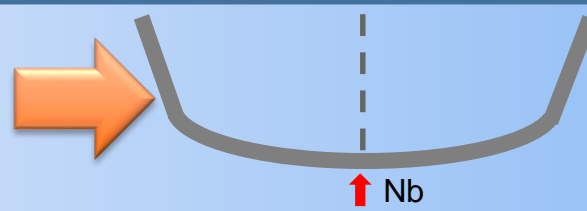
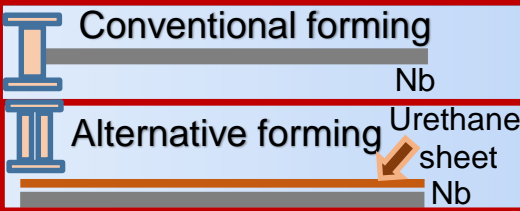
### THE TEAM

#### JAPAN :

T. Dohmae, KEK  
Y. Watanabe, KEK  
M. Yamanaka, KEK  
K. Umemori, KEK

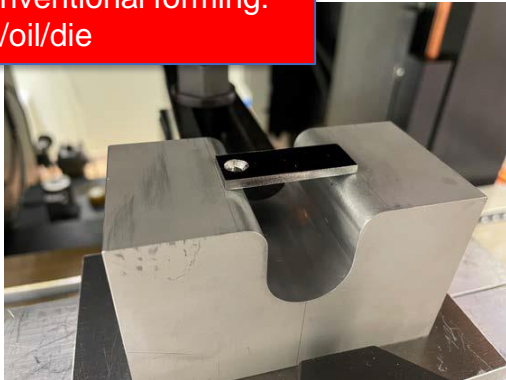
#### FRANCE :

O. Hryhorenko, IJCLab  
D. Longuevergne, IJCLab, CNRS  
C. Antoine, IRFU, CEA

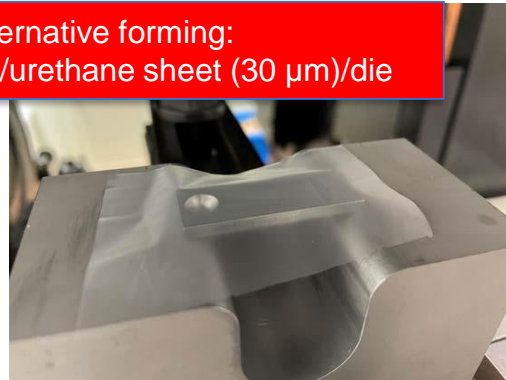


Jumping from flat geometric to curved shapes

Conventional forming:  
Nb/oil/die



Alternative forming:  
Nb/urethane sheet (30 μm)/die



Conditions compatible with  
cavity half-cells forming:  
- pressure: 6,5 MPa ~ 10 MPa

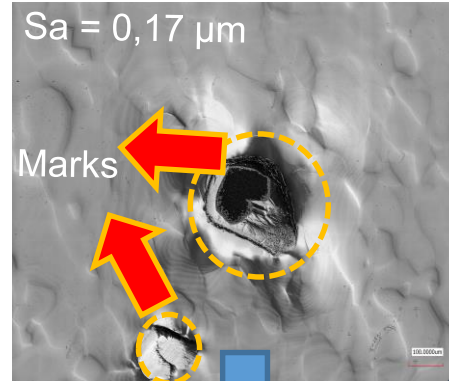
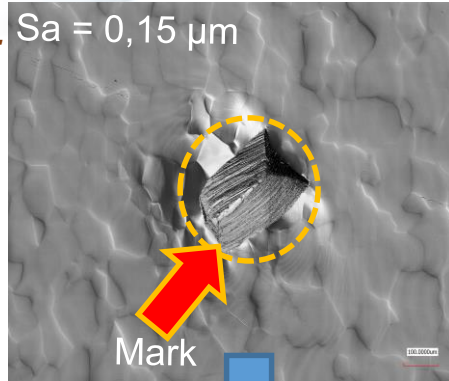


- Roughness characterization (laser confocal microscope)
- Damage evaluation (SEM microscope + EBSD)

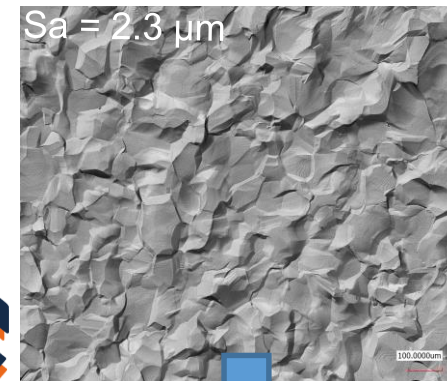
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**Before forming:**

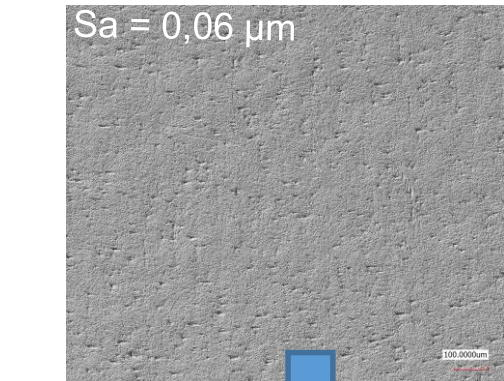
## Metallographic polishing at IJCLab



## Chemical polishing

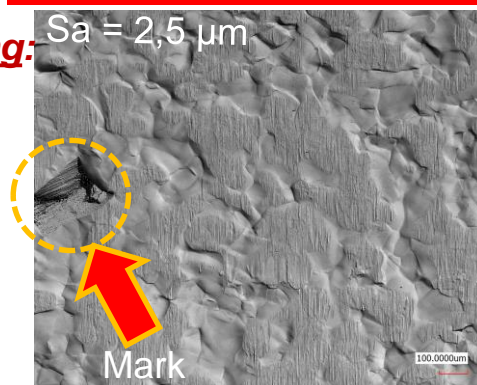


## Mechanical polishing at KEK

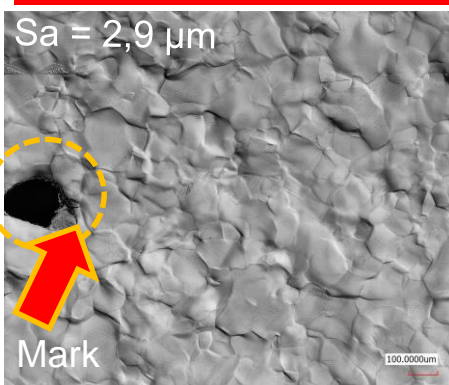


**After forming:**

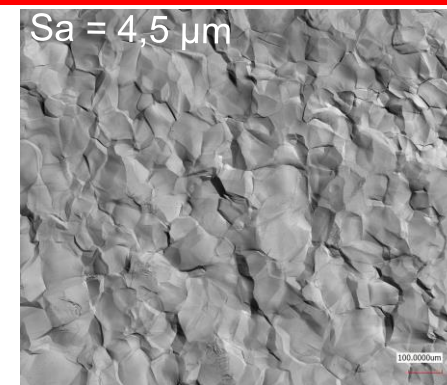
## Conventional forming



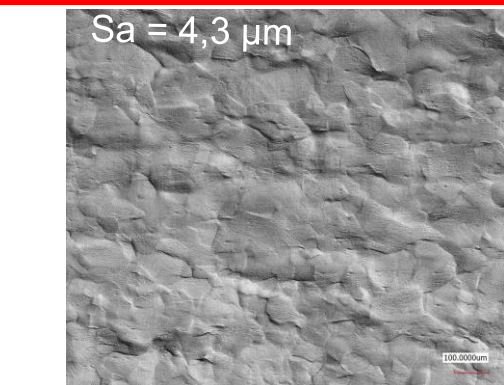
## Alternative forming



## Alternative forming



## Alternative forming



Particular deformation of the grains is caused by the surface topography (contact zones)

Urethane sheet preserves the quality of the polished grains (new GB), and gives the possibility to avoid or significantly to reduce the damages. EBSD is required



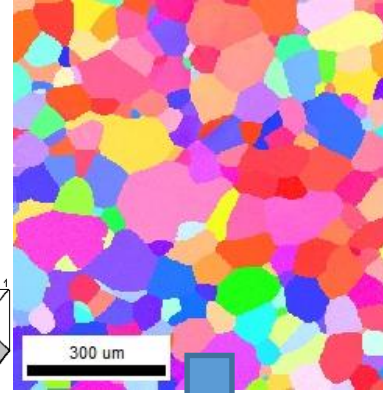
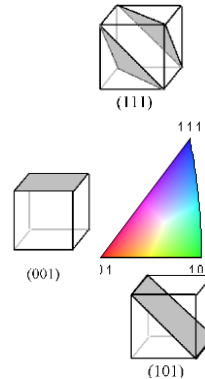
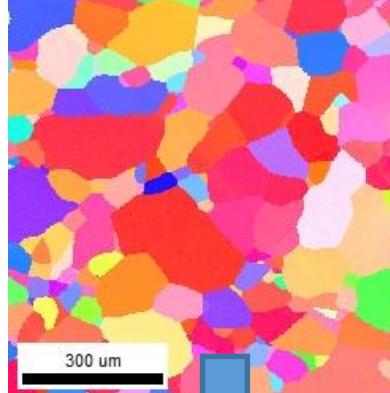
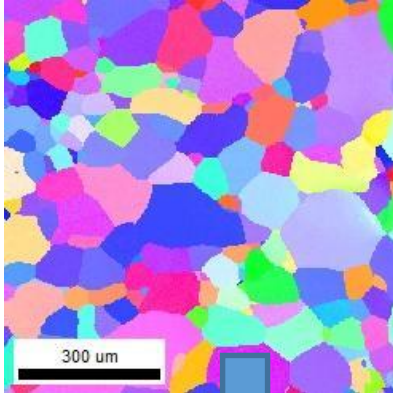
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**Metallographic polishing at IJCLab**

**Chemical polishing**

**Mechanical polishing at KEK**

*Before forming:*

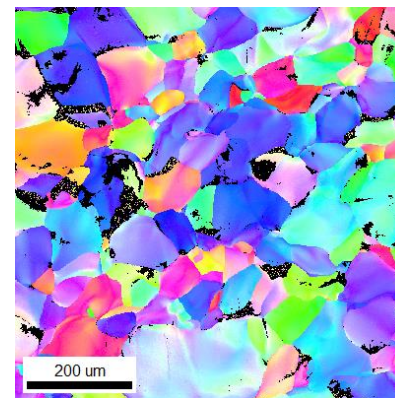
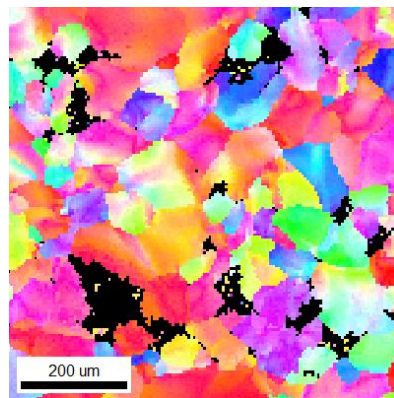
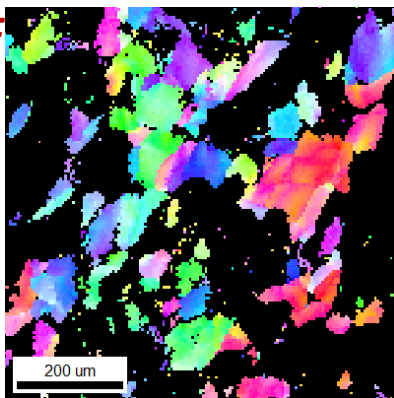


**Data is absent due to the delays connected to COVID restrictions.**

*After forming:*

**Conventional forming**

**Alternative forming**



**No signal!!!!**

Measurements have been done by F. Brisset (ICMMO lab)



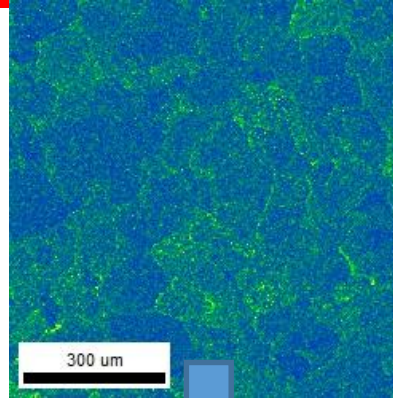
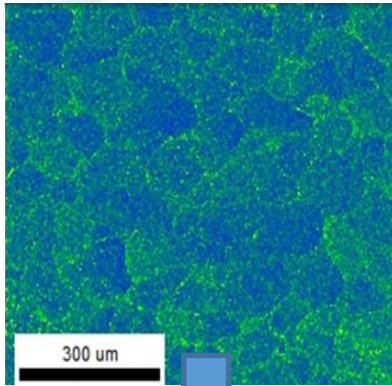
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**Metallographic polishing at IJCLab**

**Chemical polishing**

**Mechanical polishing at KEK**

Before forming:



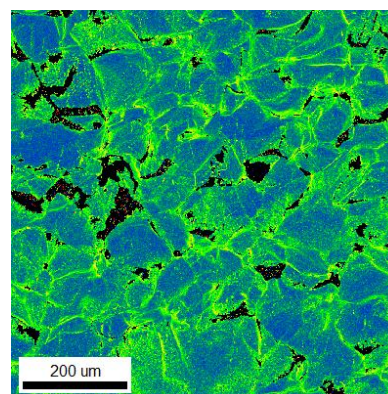
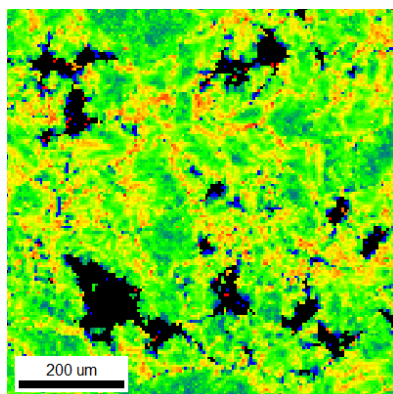
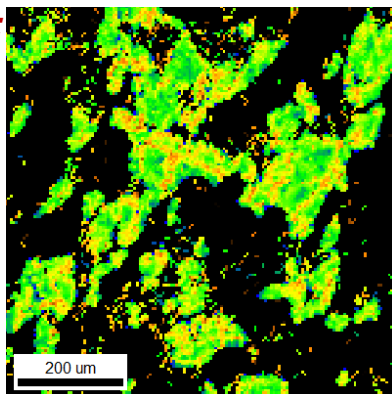
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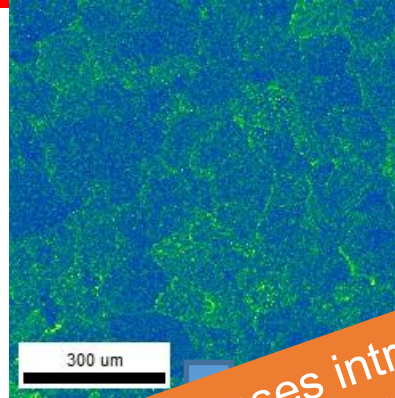
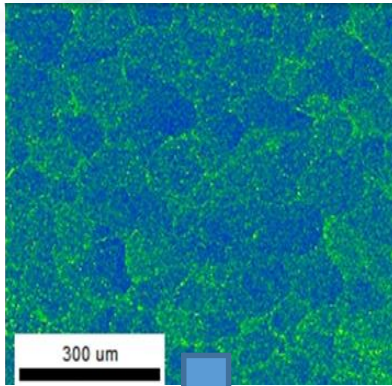
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Metallographic polishing at IJCLab

Chemical polishing

Mechanical polishing at KEK

Before forming:



Data is absent due to the delays connecting

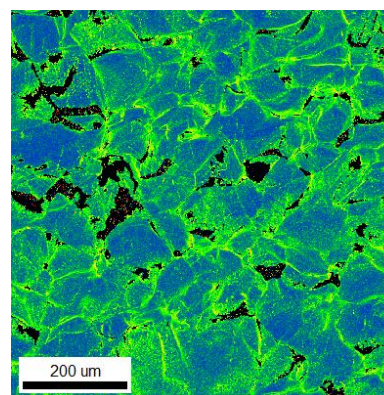
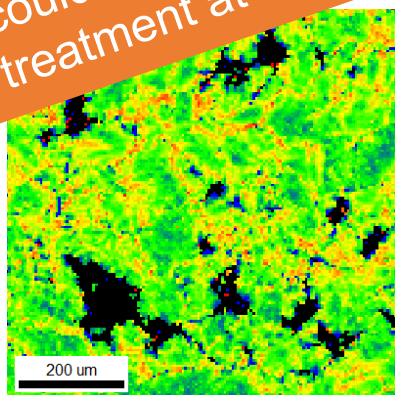
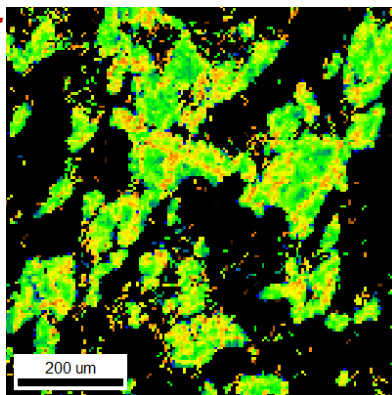
Absent data

Residual stresses introduced during deformation could be eliminated by a recovery procedure (heat treatment at medium temperatures)

After forming:

Conventional forming

Alternative forming



**No signal!!!!**

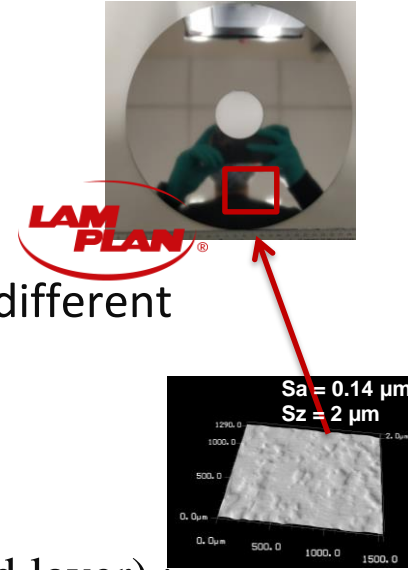
Measurements have been done by F. Brisset (ICMMO lab)



- Done in 2020:
- Polishing procedure extended to the large sheets (at LAM PLAN)
- Alternative cavity forming technique has been applied to samples polished by different techniques (metallographic, chemical, mechanical)
- Roughness and damages of the surface (face) were measured

## To be done in 2021:

- Perform the EBSD analysis of the cross-sections (evaluate thickness of damaged layer) : **may-June 2021**
- Apply the heat treatment at medium temperatures (recrystallisation)
- Send polished disk ( $\varnothing$  260 mm) by IJCLAB to KEK to form a half-cell and simulate EB welding of half-cells
- Cut the welded half-cells and analyze the surface state





**Thank you!!!**