Summary:

- It is commonly admitted that 150-200 µm need to be removed by electropolishing on the internal surface of niobium RF cavities before reaching optimal results. The proposed reason is generally the existence of a damage layer on the Nb sheet surface. Indeed recent disorientation measurement made at Cornell [1] show that hotspots exhibit higher misorientation. Damage has also been considered in the formation of pits close to the welding seam during electropolishing.

- Removing of 200 µm by electropolishing is a hazardous process, not only because of the dangerous chemicals involved in the process, but also because of the spread of results, probably due to the chemical mixture aging. Reducing the amount of electropolishing to a final light treatment would be a way to decrease both costs and risks of the RF cavities for large projects such as ILC.

- We have tried to evaluate the thickness of the damage layer after various deformations steps (mainly rolling, deep drawing and chemical mechanical polishing) by observing the density of etching figures after several light chemical etches. This provides a crude but very rapid evaluation of the thickness of the damage layer. Complementary observations with EPSB are also presented.

- Finite element, orientation imaging and/or etching figures show that the damage layer induced by rolling is noteworthy already ~150 µm thick, with a specific (001) texture that resists recrystallization.

- Deep drawing brings further and deeper damage in particular in the equator region where the friction against the forming dye is the highest. Welding also influences the damage distribution.

- Getting rid of this damage layer is possible with BCP, but it needs another 100 µm to smoothen the surface afterwards. Mechanical polishing like tumbling obviously leaves a thick damage layer, but "chemical mechanical" polishing is a way to prepare surfaces with a very thin damage layer (< 1µm?). We think that chemical mechanical polishing of half cells before welding would be a way to decrease the thickness of electropolishing necessary for the preparation of RF Nb cavities, and reduce costs and risks.

Signs of the damage layer:

- Deep etching pits (aligned with crystallographic direction ?) are found in the heat affected area.

Source of the damage layer:

- Welding speed and pre-etching of material would be a major source of damage.

Conclusions:

- Rolling and deep drawing are the main source of the damage layer.
- Mechanical-chemical polishing applied to Nb sheets on half-cells is a way to reduce electropolishing time after cavity completion.
- Annealing after deep drawing could be considered to reduce deep damage inside the material.
- Effect of welding and cooling condition need further exploration in order to reduce the amount of thermal strain embedded inside the material.
- General information on welding well documented in the 70’s80’s

References:

[5] Proc. Of the 2nd international colloquium on EB welding and melting, Avignon, (1978) ; Proc. Of the 3rd international colloquium on welding and melting by electrons or laser beams, Lyon, (1983) ; following edition of the same colloquium...

Keywords:

- Particle accelerators, RF cavities, niobium, damage layer, mechanical chemical polishing