HIGH PRESSURE RINSING PARAMETERS MEASUREMENT AND PROCESS OPTIMIZATION

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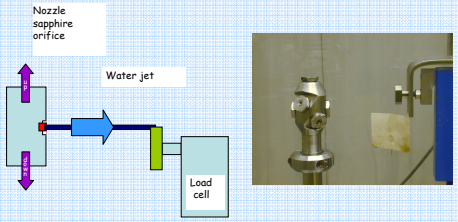
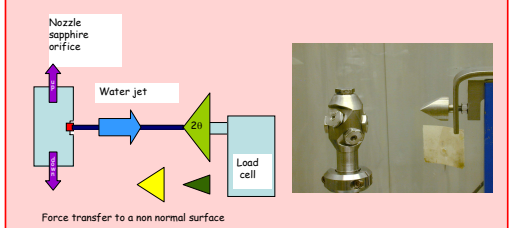
Sketch of the setup for force and profile measurement, and damage tests



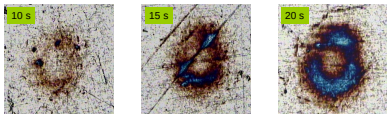
Sketch of the setup for angular dependence investigations



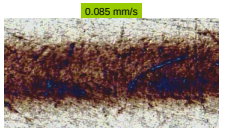
From static to dynamic HPR

To evaluate the energy deposited by the water jet on the samples, we have performed different measurements on Nb samples up to visible changes of the surface color. In the gaussian model, the energy deposited by a fixed water jet with spot size σ_0 impinging for a time τ on a sample is equivalent to the one deposited by a moving jet at speed v given by:

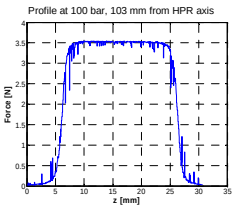
$$v = \sqrt{2 \cdot \pi} \cdot \frac{\sigma_0}{\tau}$$



Effect of a static jet (p=100 bar, σ=0.345 mm) impinging on a Nb sample for different τ.
An increasing blue area is showing up at longer time with, a growing in size, outer dark ring.



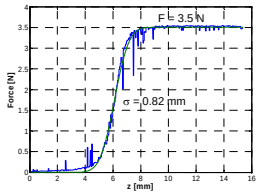
Effect of a moving jet (p=100 bar, σ=0.345 mm) impinging on a Nb sample with a speed corresponding to 10 s static jet. The presence of only small area of blue color agrees with the "10 s" static case.

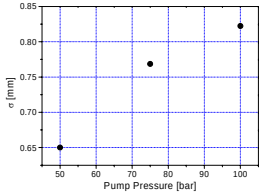


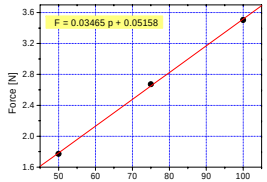
Assuming a gaussian profile for the water jet, we determine the force and the spot size interpolating the measured data with the following expression

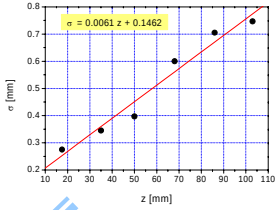
$$F(z) = \frac{F_0}{2} \cdot \left[1 + Erf\left(\frac{z - z_0}{\sqrt{2} \cdot \sigma}\right)\right]$$

where F_0 is the total force impinging on the load cell and σ the water jet spot size.







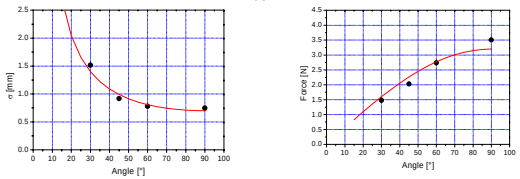


Angular dependence of force and jet spot size

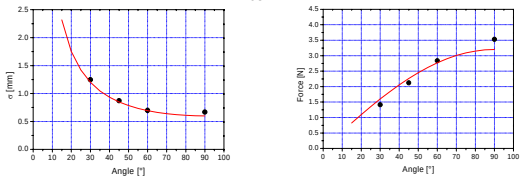
$$F = F_0 \cdot \sin(\vartheta)$$

$$\sigma = \frac{\sigma_0}{\sin(\vartheta)}$$

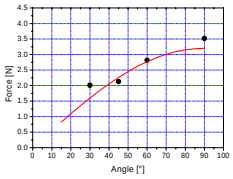
z=103 mm



z=68 mm



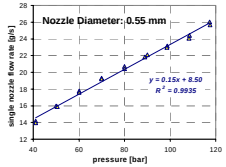
z=35 mm



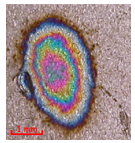
The measurements confirm the "sin" dependence of force and spot size from the angle. This is important once the cleaning effect on the curved cavity surfaces will be studied.

The characterization of the spot size versus distance and the confirmation of the angular dependence of both force and spot size will be used to optimized the HPR cleaning process.

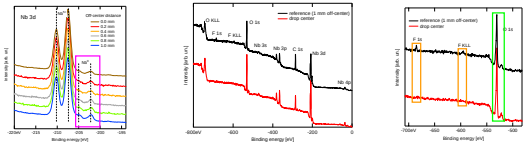
Pump and nozzle characteristics

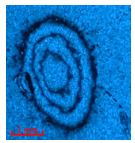


Damages @ 100 bar, z = 35 mm, Δt = 60s

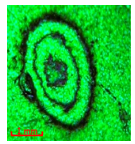


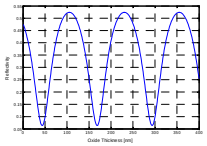
The effect of a prolonged exposition of the Nb sample to the HPR jet produces the formation of concentric ring of different colors, like interference fringes. We assume that the water jet effect is the growth of an oxide layer over the Nb surface.





The oxigen formation is confirmed by XPS analysis performed on the sample at different distances from the spot center.
The Nb signal is decreasing while moving along the spot towards the center indicating a decrease of the pure Nb content. Meanwhile, the O signal increases as well as the Nb^{5+} signal suggesting the formation of the Nb_2O_5 oxide in the "rinsed" region. As effect of the rinsing, the F signal disappears in the center of the spot.





The oxide formation has been studied using monochromatic light and the theory of optical properties of thin film. The two pictures are the same as the top picture but illuminated by laser light at the reported wavelengths. This analysis method might help in determined the thickness of the oxide layer. In particular, at 543 nm a plot of the reflectivity vs oxide thickness is shown. The minima in reflectivity correspond to the dark rings in the picture.

P = 100 bar, distance = 35 mm