Study of the liquid surface interactions on high accuracy mass standards

Lautaro Ramírez Varas [1], *Luis Omar Becerra Santiago* [2], *Claudia Santos Cardoso* [3], *Luis Manuel Peña*[2] ,*Gregorio Álvarez Clara*[2], *Victor M. Loayza*[3]

[1] Unviersidad de Costa Rica, San José, Costa Rica, lautaro.ramirezvaras@ucr.ac.cr
[2] Centro Nacional de Metrología, Querétaro, México, lbecerra@cenam.mx
[3] Inmetro, Rio de Janeiro, Brasil, cscastro@inmetro.gov.br

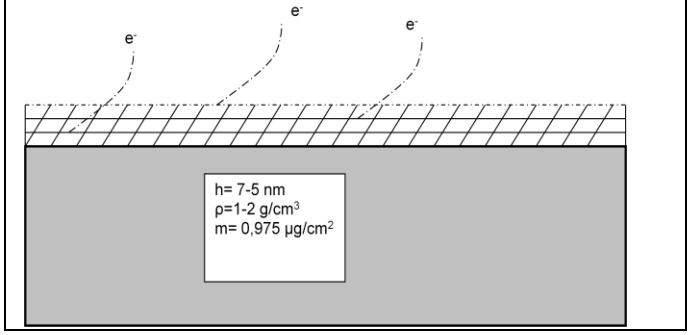
Abstract: The long term stability of mass standards depends on the interaction between their surface and environment molecules. From this point of view, a study of the effect on stainless steel surfaces by liquids frequently used in hydrostatic weighing and in cleaning procedures of mass standards was hereby investigated. Firstly mass weighing difference as function of time and pressure was measured with a gravimetric method. Additionally stainless steel samples were analyzed by X-ray Photoelectron Spectroscopy and EDS-SEM, Scanning Electron Microscopy. The standards used for the gravimetric mass difference determination was immersed in water. Mass differences were obtained with an uncertainty of 4 µg when there was a pressure gradient. Preliminary results suggest that FC40 is not chemically bound to stainless steel surfaces and the mass lost was due to physisorbed molecules on surface. Results suggest that water produces a mass gain due to adsorbed molecules on surface.

Key words: mass difference, pressure change, surface layers, XPS, EDS-SEM

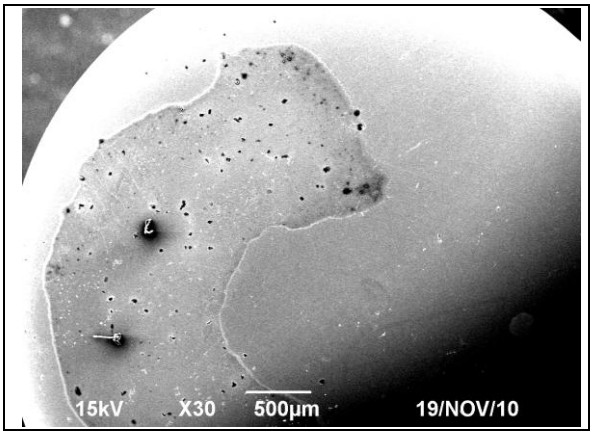
1. METHODOLOGY

By the properties of the mean path of the electrons in the XPS method, the theoretical mass adsorption can be estimated as follows:

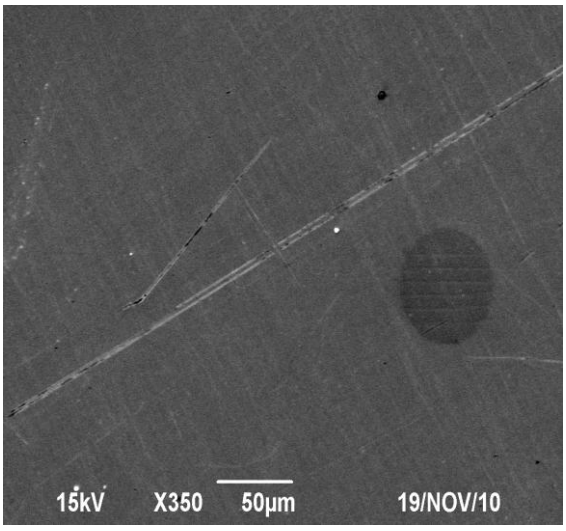
$$\frac{\rho \cdot V}{A} = \frac{m}{A} = \rho \cdot h$$



2. RESULTS



Picture XX.X Layers on the stainless steel after water treatment



Picture XX.X Layers on the stainless steel after FC40 treatment

The main design of experiment obtained was:

Pressure	Time of stability (days)

(Pa)	1		4	
101 300	-99.59 µg	-169 µg	-160.56 µg	-166.47 µg
62 000	-18.42 µg	-57.57 µg	-78.7 µg	-53.28 µg

Table XX.XX Desing of experimet

The mass difference between two conditions was calculated; the condition before the liquid treatment and the condition after the liquid treatment. The results were calculated under different pressure and time stability conditions.

The difference of the differences between two conditions is calculated as follows:

$$\Delta m_{\Delta m_x} = \Delta L_{\Delta L_{1-2}} \cdot S_b - \Delta\rho_{a1-2}(V_p - V_x) \qquad (3)$$

Where;

$\Delta m_{\Delta m_x}$: Mass variations in two consecutive conditions

$\Delta L_{\Delta L_{1-2}}$: Difference of the differences of two consecutive balance indications.

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$\Delta\rho_{a1-2}$: Difference of the air density in two consecutive conditions.

3. CONCLUTIONS

The change in pressure conditions 62 000 Pa to 101 300 Pa produces mass variations of 160 µg after an exposition to water (after hydrostatic weighing).

In the design of experiment the time of equilibrium after and immersion was not statistically significant, however the pressure change was the more important value in the model.

The theoretical mass lost (or gain) was consistent with the experimental mass lost after the immersion in the calibration liquid.

The FC40 do not interacts with the stainless steel, but removes the organic layer on the surface. The use of FC40 reduces de mass on the stainless steel surface.

The use of water in the hydrostatic weighing, increase the mass on the stainless steel surface.

AKNOWLEGMENTS

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