

Water vapour adsorption effect

For some research projects, it is necessary to take into account the effect of water adsorption between vacuum and air. To study such surface effects on mass standards, gravimetric and ellipsometric methods are used at the BIPM. Measurements carried out under atmospheric air by changing the relative humidity allows one to estimate the adsorbed water amount as function of air humidity. The effect of cycling between vacuum and standard atmospheric air has also been investigated. The same Pt/Ir, stainless steel and silicon mass standards were used for two methods.

- Gravimetric determination

This method measures the changes in mass difference between two artefacts having the same nominal mass and the same volume but with very different surface area. The following photos show the artefacts used at the BIPM for this study. Measurements were performed inside the FB2 balance case of the BIPM, which permits relative air humidity control and vacuum operation.



Two 1 kg Pt-Ir ($\Delta S = 77.8 \text{ cm}^2$)



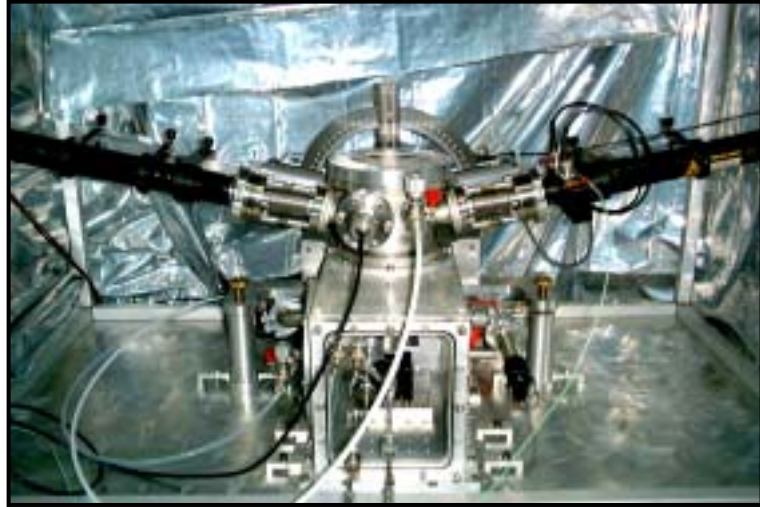
Two 1 kg Stainless steel ($\Delta S = 144 \text{ cm}^2$)



Two 115 g silicon ($\Delta S = 42 \text{ cm}^2$)

- Ellipsometry

Ellipsometry is the determination of changes in the state of polarization of light upon reflection from a plane surface. If a physical model is available, the thickness of a thin film covering a reflecting surface may be calculated from the additional change it causes. At the BIPM, we use a commercial phase-modulated ellipsometer. Samples are placed inside an air-tight chamber having the possibility to change the relative humidity of air and to make evacuation.



Experimental set-up of the ellipsometer used for investigation of water adsorption effect on mass standards.

Compared to the gravimetric method, which is a global and direct measurement, ellipsometry is more sensitive and faster. Nevertheless, it is a localized (analysed surface area 1mm^2) and indirect determination. The determination of the thickness needs an assumed model to interpret ellipsometric parameters.

In general, coherent results of different mass standards were achieved between the two methods. The Sorption effect on the silicon samples was smaller than that for Pt/Ir and stainless steel samples. The thickness of the adsorbed water layer from vacuum to standard atmospheric air of 45 % humidity was between 0.2 nm to 1 nm. The obtained adsorption coefficient in air was between 0.6 nm/h and 1.0 nm/h. This work is continuing.