X-Ray Photoelectron Spectroscopy - XPS or ESCA

XPS is a vacuum technique where a stream of mono-energetic X-rays is focused onto the sample surface resulting in a number of photoelectrons being emitted. The electron energy analyzer measures the binding energy of the photoelectrons. From the binding energy and intensity of a photoelectron peak, the elemental identity, chemical state and concentration of an element can be determined. In the outermost 10 nm of a surface, XPS can provide:

- identification of all elements (except H and He) present at concentrations > 1 - 0.1 atomic %;
- semi-quantitative determination of the elemental surface composition;
- information about the molecular environment (oxidation state, bonding atoms, etc.);
- non-destructive elemental depth profiles 10 nm into the sample (angle resolved XPS);
- destructive elemental depth profiles several hundred nanometers into the sample using ion etching;
- lateral variations in surface composition (spatial resolution of 8-100 µm, instrument related).

The information XPS provides about surface layers or thin film structures is of value in many industrial applications including: polymer surface modification, catalysis, corrosion, adhesion, semiconductor and dielectric materials, electronics packaging, magnetic media, thin film coatings …

Instrumentation @ SURF:

- On the PHI-5600ci both a monochromatic Al Kα source and a dual Al-Mg anode are present. It is also equipped with an Auger electron analyser. The absolute energy resolution of the hemispherical analyser (HSA with 12 channels) is 0.5 eV on silver. The minimum analysed spot size is 100 µm diameter (omnifocus lens 4).

A sputter ion gun is provided and used for the removal of surface contamination and for XPS composition depth profiling capability. During sputtering, Zalar rotation can be applied in the PHI-5600ci system.

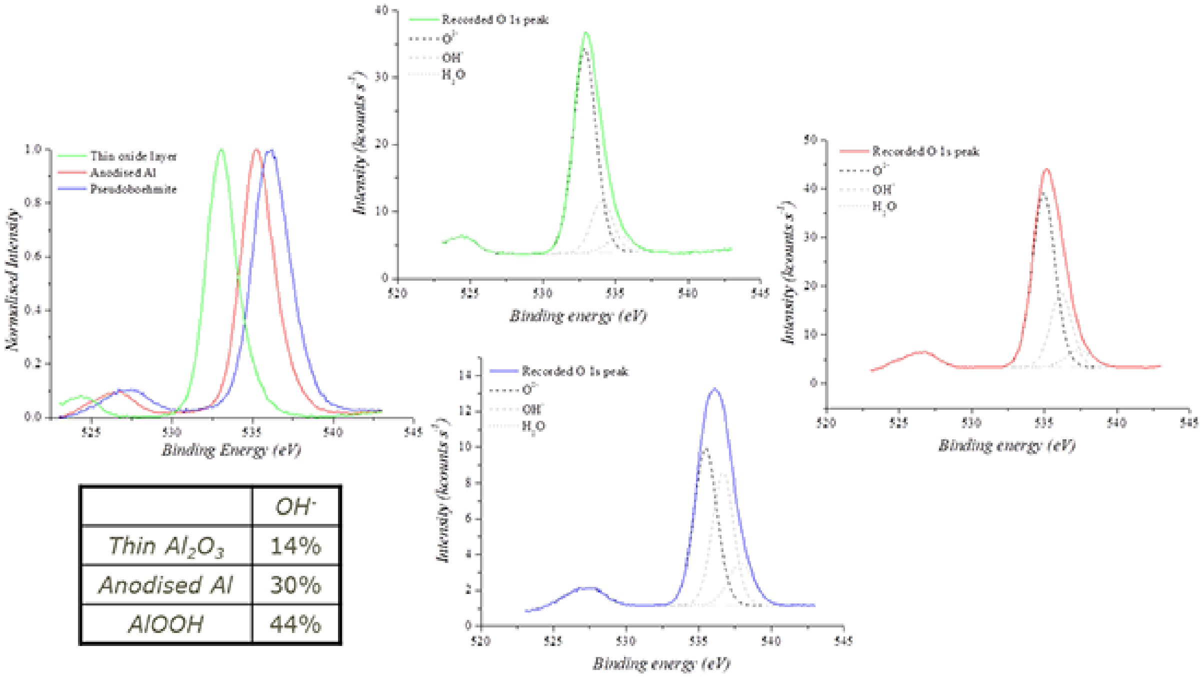
Sample requisites:

- samples should be relatively flat;
- maximum size : 2 cm x 2 cm (maximum height 0.5 cm).

A few examples of previous or on-going case studies:

- growth mechanisms of passivation and hydration layers on different metal surfaces;
- growth of polymers on Si;
- self-assembling monolayers on aluminium;
- self-healing coatings;
- study of cerium particles in coatings;
- study of Pt-nanoparticles on carbon…

As an example, the XPS spectra recorded on different aluminium oxides are shown in the figure below. It is shown how curve fitting of the O 1s peaks is used to estimate the hydoxyl fraction in each aluminium oxide.



	OH^-
Thin Al_2O_3	14%
Anodised Al	30%
AlOOH	44%