Atomic Force Microscopy - AFM

Atomic force microscopy is a method of sample surface topography imaging. The topography image is observed by means of forces between a sharp AFM tip and the sample surface atoms in the order of nano Newtons.

Through microfabrication technology nano sized needles (tips) are placed at the end of Si springs and are used as force sensors. AFM systems also have laser subsystems. The laser beam is focused at the tip edge and the deflection of the beam can be measured with a photodetector. When the tip scans the sample surface, the force between surface atoms and tip is kept constant by using a feedback system. The measured tip movement gives the surface topography image of the sample.

AFM systems have different application areas that depend on material properties, e.g., abrasion, monolayer formation, magnetic properties, surface roughness… Electrochemical scans can also be carried out on a nano scale to study corrosion mechanisms, mono layer formation, initiation hotspots… Analysis techniques such as AES (Auger electron spectroscopy), FE-SEM (field emission scanning electron microscopy), SE (spectroscopic ellipsometry)… also available in our department, are recommended to obtain complementary information for certain samples.

Instrumentation @ SURF:

- Park AFM XE-100
- Veeco CPII

With those two instruments, following techniques can be performed:

- surface topography:
    - contact mode;
    - non-contact mode;

  - tapping mode;
  - scanning tunnelling microscopy - STM;
- local potential mappings:
  - scanning Kelvin probe force microscopy - SKP/FM.

SKP/FM measurements are performed to identify intermetallic phases formed in hot dip coatings on steel. This technique allows to obtain simultaneously potential and topography mappings in non-contact mode regime. As result, electrochemical characterisation concerning the nobility of the different phases can be related with topography data.

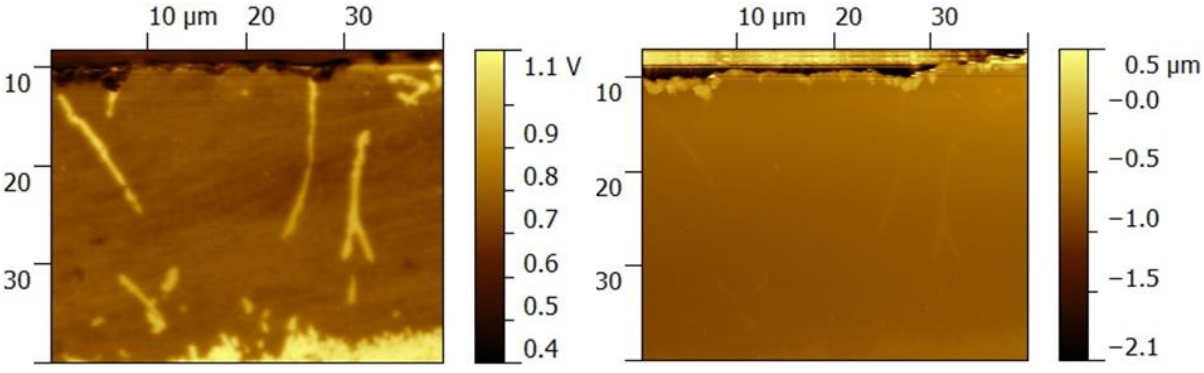
Sample requisites:

- samples should be flat;
- sample preparation is very simple and the whole process is non-destructive (except in the case of in-situ measurements);
- particularly for SKP/FM measurements, very flat samples are required as well as an electrical connection between the sample and the sample holder.

Examples of previous or on-going case studies:

- formation of self-assembling monolayers on Al;
- intermetallics characterisation on metallic coated steel;
- passivation layer initiation hotspots;
- pretreatment effects on different metals…

In the figure below an example of a potential and topography mapping is shown in an aluminium coating on steel. It can be observed that although topography shows not many differences in height, the potential mapping indicates that the brighter zones are more noble than the surrounding aluminium matrix.



Potential and topography mappings obtained by the SKP/FM