Local Electrochemical Techniques Used For Spatially-Resolved Surface Analysis

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Applications: corrosion, coatings, battery materials, sensors, catalysts, analytical electrochemistry, photovoltaics

Scanning Electrochemical Microscopy (SECM)

Aim: assessing in operando the reactivity of a surface towards an electrochemical reaction.
Principle: an Ultra Micro Electrode is electrically polarized to undergo a redox reaction. As the probe is close to a sample, the rate of the reaction depends on the conductivity or reactivity of the surface towards this reaction.

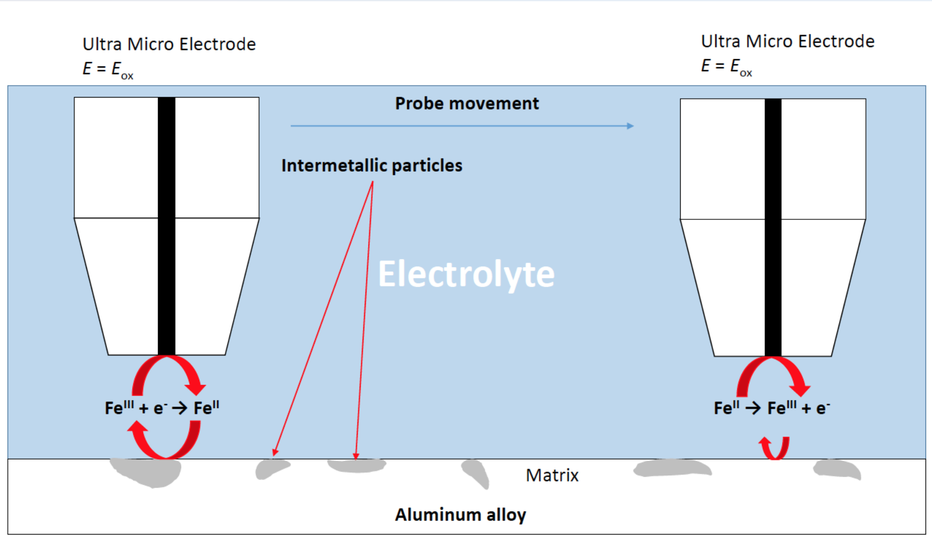

Figure 1. SECM principles.

Corrosion is more likely to occur due to galvanic coupling between matrix and particles.

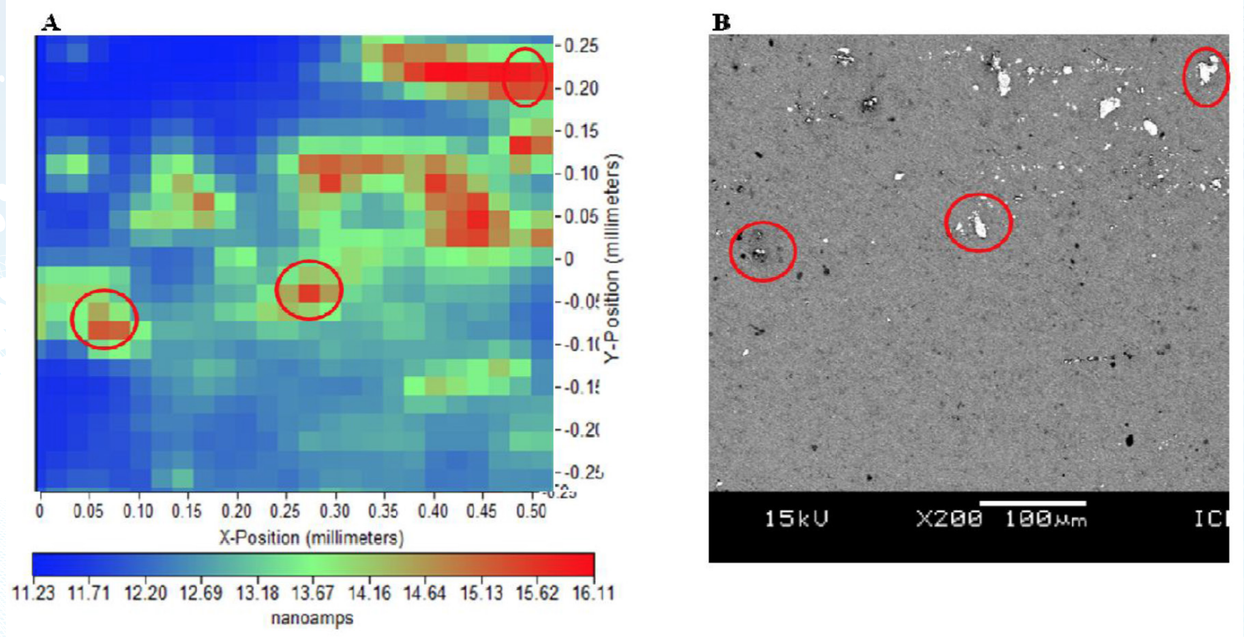

Figure 2. A) SECM map on 2050-T8 alloy B) SEM picture in chemical contrast mode [1].

Al-Cu-Fe-Mn particles visible in SEM are circled in both pictures.
They show a higher reactivity than Al matrix in 10 mM K_3FeCN_6 and 0.5 M K_2SO_4.

Scanning Vibrating Electrode Technique (SVET)

Aim: assessing in operando the local corrosion kinetics of a heterogeneous surface.
Principle: a potentiometric tip is used to measure the local ionic current flowing over the surface.

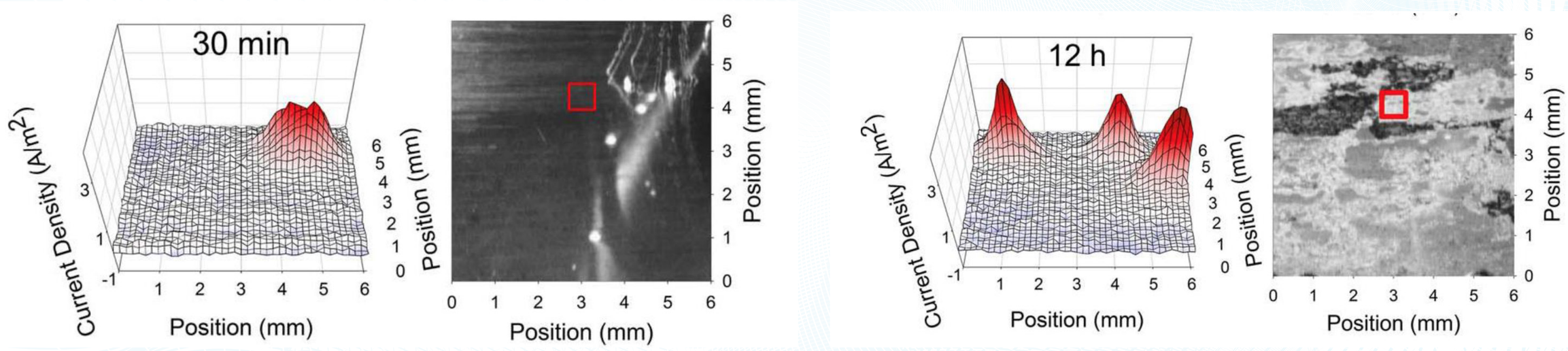

Figure 3. SVET plots and scan area images of the working surface of AM30 Mg-Alloy taken at various times after immersion at the OCP in 0.05 M NaCl [2].

The SVP technique allows to understand the phenomenology of corrosion propagation.

Scanning Kelvin Probe (SKP)

Aim: assessing the local work function differences of the components of a heterogeneous surface.
Principle: a metal wire is connected to the sample forming a capacitor. The potential needed to null the surface charge difference is the Kelvin potential.

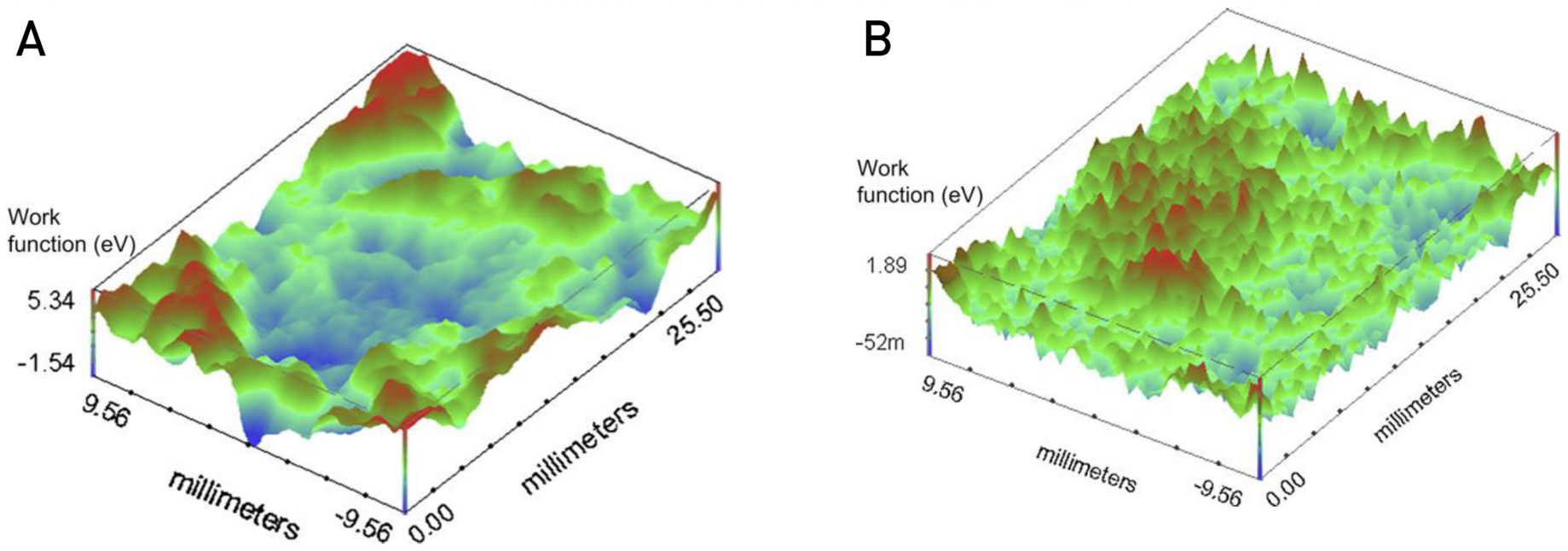

Figure 4. Work function measured after 120 h of immersion of a metallic substrate in 0.35% M NaCl. A) melamine coating, B) phenolic coating [3].

The SKP technique allows to qualify the local electronic properties of a surface and deduce relative electrochemical potentials.

References

[1] D. Sidane, Thesis, ICMC Bordeaux, 2012
[2] Z. P. Cano, J. R. McDermid and J. R. Kish, J. Electroch. Soc., 162 (14) C732-C740 2015
[3] F. Deflorian, S. Rossi, M. Vadillo and M. Fedel, J. Appl Electrochem., 39, 11, 2151–2157, 2009

These results were obtained using BioLogic equipment.