Simultaneous Topographical And Electrochemical Mapping Using Scanning Ion Conductance Microscopy – Scanning Electrochemical Microscopy

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Lately, scanning ion conductance microscopy (SICM), has emerged as a versatile non-contact imaging tool. To obtain spatially-resolved electrochemical information, scanning electrochemical microscopy (SECM), also known as the chemical microscope, has been developed [1]. In hybrid SICM-SECM techniques, the SICM compartment provides the accurate probe-sample distance control, while the SECM compartment measures the faradaic current for electrochemical information collection [2].

In this work, we demonstrate the use of an Atomic Force Microscopy (Park NX10) in combination with an ammeter for concurrent topography imaging and electrochemical mapping. The SICM-SECM probe consisted of a Au crescent electrode (AuE) on the peripheral of a nanopipette. High resolution probe-substrate distance control was obtained by the ion current feedback from SICM, while simultaneous electrochemical signal collection was achieved via the AuE from SECM.

As a proof-of-concept experiment, an Au/Pyrex pattern standard sample was imaged with the SICM-SECM technique. The Au bar and the Pyrex substrate were clearly resolved from the SICM topography image, with the bar height and pitch width closely matching the actual values. In terms of the electrochemical property mapping, higher Faradaic current was seen when the probe was scanned over Au bar as a result of redox cycling, while lower Faradaic current was observed when the probe was over Pyrex substrate due to hindered diffusion (Figure 1). The capability of the SICM-SECM technique described here holds promise of many applications in the field of electrochemistry, material science and nanoengineering.

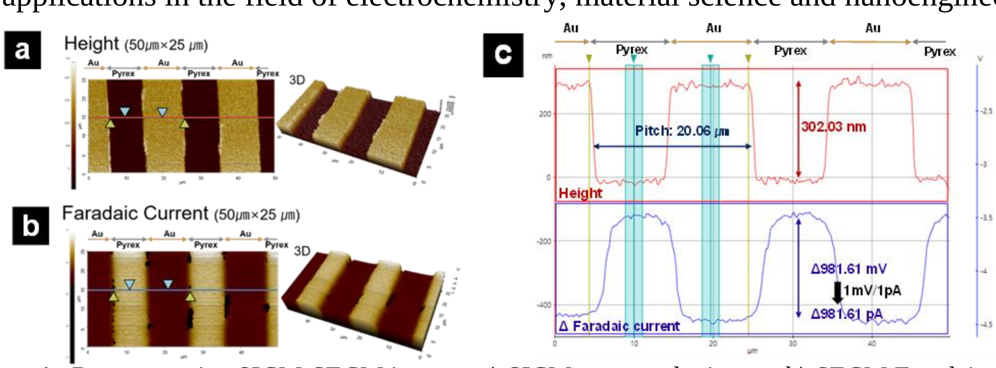

Figure 1. Representative SICM-SECM images. a) SICM topography image; b) SECM Faradaic current image. c) Line profile along the line seen in a) and b). Image size: 50 µm × 25 µm.

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[2] Shi, W. et al., Faraday discussions, 193, (2016), 81-97.

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