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M. Szociński [1], Dr.,
K. Darowicki [2], Prof. Dr.
(GUT, Gdansk, Poland,
[1] michal.szocinski@pg.edu.pl,
[2] kazimierz.darowicki@pg.edu.pl)

COMBINATION OF ELECTROCHEMICAL IMPEDANCE SPECTROSCOPY AND ATOMIC FORCE MICROSCOPY FOR CHARACTERIZATION OF ORGANIC COATINGS

Electrochemical impedance spectroscopy (EIS) is a recognized and widely applied technique used for investigation and characterization of organic anticorrosion coatings for many decades [1]. Apart from a number of benefits, such as non-destructive character, sensitivity to resistive-capacitive changes of the system under investigation or possibility of field measurements, in its classical approach EIS possesses also some drawbacks including averaging character of measurements, typically pertaining to the investigated area of cm^2 order. However, there are certain cases when the information about local coating behaviour is of interest, for example in electronic industry for evaluation of conformal coatings condition on printed boards or when identification of degradation onset site is crucial. These tasks call for a measurement technique, which provides insight into local electrical properties of coating, thus overcoming averaging shortage of the classical EIS.

To solve this problem the authors propose an approach based on the atomic force microscopy (AFM) technique operating in a contact mode. That methodology had been applied by Shao et al. to investigate polycrystalline ZnO [2], but it had not been implemented in the field of coatings. Either dc bias voltage or ac voltage perturbation signal is applied between conductive AFM probe and metallic substrate covered with the organic coating under investigation. In this way not only topographical images but also local electrical characteristics are acquired. The latter include local dc current maps, local impedance maps of the investigated area and/or local impedance spectra collected at the region of interest.

The authors have successfully applied this approach as a complementary technique with respect to the classical electrochemical impedance spectroscopy. It allowed obtaining additional information about local performance of organic coatings in such types of research as: identification of organic coating degradation onset [3], assessment of durability of confor-

mal coatings in electronics [4], monitoring of protective mechanism transition in zinc-rich coatings [5] and many more.

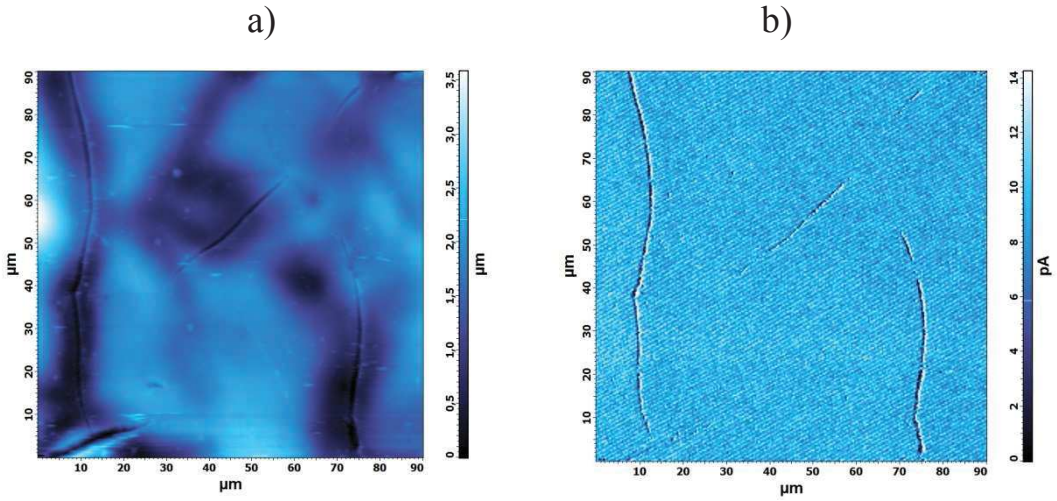

Figure 1 – Example of AFM topographical image (a) and corresponding local dc current map (b) of epoxy conformal coating on electronic printed board after six-year service [4]. Higher values of local current detected in the scratches help to decide if the damage is through-the-coating defect.

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