TECH HIGHLIGHTS

In Situ Underfilm Corrosion Rate Measurements by Magnetic and Electrochemical Techniques

Organic coatings are commonly used for corrosion protection. However, corrosion of the underlying metal resulting from coating flaws or diffusion of water through the coating can be difficult to measure. Weight loss/gain measurements can be confounded by uptake of water in the coating. Electrochemical impedance spectroscopy (EIS) is widely used to study underfilm corrosion but has some serious drawbacks. A research team from the Massachusetts Institute of Technology in the United States, the University of Naples in Italy, and the University of Manchester in the United Kingdom have enhanced the value of real-time EIS by coupling it with saturation magnetic moment measurements using a vibrating sample magnetometer (VSM). The researchers found that by using this coupled technique, the corrosion rate beneath an organic coating could be measured accurately *in situ*. This technique can be applied to organic-coated ferromagnetic metals that do not produce ferromagnetic corrosion products. Further, there is evidence that VSM measurements could be used to enhance the interpretation of EIS data.

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Plasma-Activated Room-Temperature Wafer Bonding

Researchers at Chalmers University of Technology in Sweden have investigated room-temperature wafer bonding processes using oxygen and argon plasma activation of silicon, silica, and AT-cut quartz. Traditional wafer bonding methods use wet chemical activation and require annealing at temperatures around 1000°C. In many cases, however, these temperatures are unacceptable, such as in sensor fabrication where metal wires are already present. Therefore, plasma activated, room-temperature wafer bonding has attracted attention over the past few years. Amirfeiz, *et al.* have carried out a study aimed at understanding the mechanism of the plasma activation and evaluating the electrical characteristics of the bonded interface. Through surface energy, infrared spectroscopic, electrical, and other measurements, they have found that covalent Si-O-Si bonds are formed more rapidly than would be expected based on room-temperature out-diffusion of the interfacial water through silica. The authors suggest that the high removal rate can be explained by a porous, disordered structure of the oxide. This hypothesis is also supported by the discrepancy between the oxide thickness as measured by AFM and by capacitance-vs.-voltage curves. The researchers found that the bonded interfaces exhibit high surface energies, comparable to what can be achieved with wet chemical (SC1) activation followed by high temperature (600-800°C) annealing.

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Storage and Release of Cr(VI) in Chromate Conversion Coatings

Hexavalent chromium is generally accepted to be the critical component in corrosion protective coating systems used in aluminum engineering alloys such as $AA_{2}0_{24}$-T_{3}. The ability of a chromate conversion coating (CCC) to release Cr(VI) as a soluble species is considered to be important in the self-healing property exhibited by CCCs, in which chromate or a related compound migrates to defects or corrosion sites to inhibit further damage. Researchers at The Ohio State University have described the results of quantitative experiments aimed at elucidating Cr(VI) storage and release mechanisms in CCCs. They used ultraviolet-visible absorbance spectroscopy to measure the solution Cr(VI) concentration for CCC films of assorted areas and coating weights immersed in a variety of solution volumes. Their results are consistent with a mechanism similar to a Langmuirian adsorption-desorption equilibrium of Cr(VI) on a porous, insoluble Cr(III) hydroxide matrix. They have developed a model based on this mechanism, which quantitatively predicts the observed solution concentrations of Cr(VI), explains the capacity of a CCC to release active Cr(VI) corrosion inhibitor, and indicates that Cr(VI) storage in a CCC involves reversible formation of a Cr(VI)-O-Cr(III) mixed oxide.

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Nanostructured Tin Oxide Anode for Li-Ion Batteries

Lithium-ion batteries are becoming the power sources of choice in modern consumer electronic devices. Although commercially available, these batteries are still the subject of intense research aimed at developing improved electrode and electrolyte materials. Anodes derived from tin oxide are of considerable interest because they can, in principle, store more than twice as much Li$^+$ as the carbon-based materials currently employed. Researchers at the University of Florida in Gainesville and the University La Sapienza in Rome have reported excellent performance characteristics for a nanostructured tin oxide-based electrode fabricated by the template method. The electrode was fabricated by a solution-based method wherein tin(II) chloride was deposited in the ~ 50 nm diameter pores of a porous polycarbonate membrane. The membrane was burned away in an oxygen plasma, and the resulting nanofibers were heated at 440°C to convert them into crystalline tin oxide. The resulting electrode has extraordinary rate capabilities, can deliver very high rate capacities (> 700 mAh/g at a discharge rate of 8 C), and retains the ability to be charged and discharged for as many as 800 cycles. The authors attribute these performance attributes to the small size of the nanofibers that make up the electrode and the small domain size of the tin grains within the nanofibers.

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Tech Highlights was prepared by Vicki Edwards of Corning, Inc., and Terry Guilinger and Mike Kelly of Sandia National Labs.

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