A Flow-Through Cell for Analysis of Thiosulfate

The ongoing search for environmentally friendly chemical processes dictates that technologies for monitoring these processes be concurrently developed. In the area of gold recovery, thiosulfate is an alternative to traditional cyanide-based processes. Because thiosulfate concentration can change continuously due to oxidation, Process stream concentrations must be monitored in real time. Breuer and co-workers at Monash University in Australia have developed a flow-through monitoring technique that is based on measuring the current associated with Ag oxidation. Because Ag selectively complexes with thiosulfate, the Ag oxidation current is determined by the thiosulfate concentration. A simple measure of the total current on a silver electrode does not give a good estimate of thiosulfate concentration, however, due to errors introduced by other redox processes associated with other species in the process stream (*e.g.*, Cu(II) reduction and Cu(I) oxidation). Rotating electrochemical quartz crystal microbalance experiments made it possible to differentiate between the measured current and that calculated from the detected mass change accompanying Ag oxidation. The most accurate measurement was obtained when the potential for Ag oxidation was chosen to be close to the reversible potential for Cu(I)/Cu(II). Furthermore, a linear relationship was found between the redox rate for copper on Pt and the corresponding rate on Ag. Based on these findings, the authors were able to construct a simple and robust detector for thiosulfate based on correcting the current measured on Ag with that measured on Pt.

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A Detailed Study of Crevice Corrosion Scaling Factors

A major issue in quantitatively characterizing the crevice corrosion susceptibility of materials in relevant geometries has historically been the inability of researchers to produce well-defined crevices with rigorously controlled spatial parameters comparable to real applications. Researchers at the University of Virginia have developed a straightforward technique using photolithographic procedures that enable the production of crevices whose geometry is limited only by the surface finish of the base material. This technique was utilized to form sub-100 μm crevices on nickel, and the crevice corrosion susceptibility of this material was assessed in sulfuric acid. Computational modeling was combined with experiment to assess the performance of these samples and the overall nature of crevice corrosion initiation and propagation in the Ni/H_2SO_4 system. The authors established conclusively that the quadratic scaling factor applies to crevice corrosion. In addition, the time-dependent development of the current distribution within the crevice was demonstrated to be controlled both by the crevice gap and depth. Finally, the authors established that the IR* theory is insufficient to describe the crevice corrosion mechanism for the Ni/H_2SO_4 system at small crevice gaps, and that electrolyte surface tension also plays an important role.

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A Miniature Fuel Cell with Monolithic Si Electrodes

Silicon microfabrication technology is an attractive approach for producing miniature fuel cells, and applications of these fuel cells as power sources for portable electronic systems are envisioned. One of the challenges in adapting microfabrication methods to miniature fuel cells is preparation of the catalyst layers. Recently, researchers at the Tokyo Institute of Technology reported the fabrication of monolithic silicon fuel cell electrodes. In their approach, fuel channels were first formed by a combination of common photolithographic and caustic etching steps. Then, a porous silicon layer was formed through the bottom of the fuel channels by anodization in hydrofluoric acid (HF). Catalyst metals were deposited inside the porous silicon layers by an electroless deposition process that was enhanced by addition of dilute HF to the plating solution. The two fuel cell electrodes were hot-pressed onto either side of a Nafion 112 sheet to form the membrane electrode assembly. An open-circuit voltage of 840 mV and a maximum power density of 1.5 mW/cm^2 were observed for a prototype 250 μm thick fuel cell supplied with hydrogen and air. Such performance is comparable to similar miniature fuel cells prepared with conventional carbon-support catalyst layers.

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Inhibition of Lithium Dendrites by Fumed Silica-Based Composite Electrolytes

The use of lithium metal as an anode in secondary batteries holds enormous promise due to lithium's high negative potential and large specific capacity. However, the formation of dendrites during recharging has limited practical applications of this technology. While polymeric separators show an improved ability to inhibit dendrites compared to liquids, they exhibit poor conductivity at room temperature. One approach proposed to circumvent this issue is to use fumed silica to immobilize the liquid separator, thereby forming a composite with solid-like mechanical properties and liquid-like conductivity. Previous experiments suggested that the continuous network formed by fumed silicas can inhibit dendrite formation, but no direct evidence has been reported. Zhang and co-workers from North Carolina State University used *in situ* microscopy to track the formation of dendrites during lithium deposition, both with and without the addition of fumed silica. The micrographs clearly show inhibition of dendrite formation with addition of the filler. The authors conclude that the fumed silica forms a continuous network in the electrolyte and also helps form a smooth, thin passivation layer on the surface of the lithium due to the scavenging of impurities. Both factors are hypothesized to be crucial in the inhibition of dendrite formation.

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A Novel Gettering Technique for Thin SOI Wafers

There has been dramatic progress in silicon-on-insulator (SOI) materials over the past two decades. SOI substrates hold potential for production of microelectronic products with higher densities, smaller chip sizes, higher device speeds, and lower power requirements. In these advanced devices, heavy metal impurities must be eliminated from the device region. Conventional back-side and intrinsic gettering techniques are ineffective for thin SOI wafers because the buried oxide layer acts as a diffusion barrier for heavy metal impurities. Researchers at the Himeji Institute of Technology in Japan have described a novel gettering technique wherein a polycrystalline silicon film is deposited on the SOI device layer. Thermal annealing at 500-600°C allows heavy metal impurities to diffuse from the device layer to the polycrystalline silicon. Following this gettering step, the polycrystalline silicon film is removed by photoetching, a field oxidation step is performed, and the entire device region is protected by a thick insulating film. This procedure protects the device layer from contamination during the numerous subsequent steps of the very large-scale integration (VLSI) fabrication process. Reduction in the density of interface trap charges in metal oxide semiconductor field-effect transistor (MOSFET) devices was among the experimental results pointing to the efficiency of this gettering approach.

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