Microdisk Arrays for Peroxide Analysis in Water

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Peroxides are increasingly being used for bleaching and disinfections applications. Peroxide (H_2O_2 and PAA) analysis using a gold microdisk array is demonstrated for monitoring a typical wash liquor media.

Hydrogen peroxide (H_2O_2) and peracetic acid (PAA) are used as bleaching and disinfecting agents. The bactericidal and algaecidal properties of peroxides [1] and the advantage that they decompose into harmless residues, make them suitable for a broad range of applications, including oxidizing and bleaching agents in laundry formulations, sanitization of food equipment, paper bleaching and medical sterilization equipment.

Microdisk arrays integrated on silicon chips have been successfully applied to on-line monitoring of chlorine and ozone disinfecting agents. Based on this know-how, peroxide analysis was evaluated in order to extend the use of the same technology to a commercially important analytical field [2]. Initial tests were conducted in model wash liquors. Peroxides added to laundry products and processes increase cleaning, hygiene (bacterial kill) and specific stain removing. However, excessive peroxide concentrations cause color fading, substrate degradation and cost increase of a product or a process. Hence, monitoring the concentration of peroxides in wash liquors is of high interest.

H_2O_2 amperometric detection through the electrochemical reduction of H_2O_2 to water resulted in an excellent linearity up to the required limit of 350 ppm. Reduction on the gold microelectrode is however strongly inhibited by the adsorption of surfactants (1 g/l dodecylbenzene sulphonic acid sodium salt). It was found that this effect could be overcome by using a pulsed detection procedure. After desorbing the surfactant at an anodic potential, the polarity is switched to the cathodic measuring potential and the reduction current is read before re-adsorption takes place ($\leq$ 2 s). The low parasitic capacitive current and the short response time of microelectrodes are decisive advantages for this procedure. Figure 1 shows the excellent linearity and the identical responses obtained in hydrogen peroxide solutions without and with surfactant.

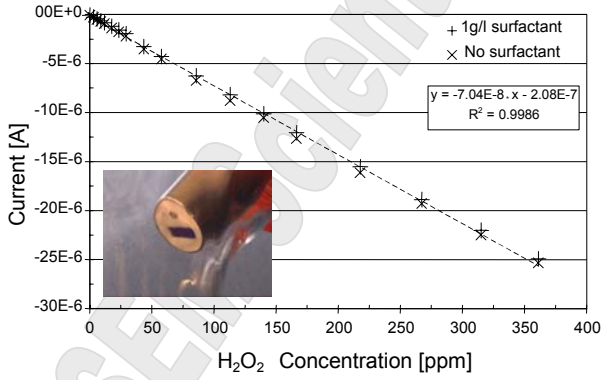

Figure 1: Microelectrode array response to hydrogen peroxide reduction in water, without and with surfactant

PAA is important because it is highly reactive and reacts at low pH (> 5) and low temperature (> 10 C). Peracetic acid always contains hydrogen peroxide (H_2O_2) due to its fabrication process or decomposition mode. Selective analysis of PAA in the presence of H_2O_2 is therefore required. The fact that the reduction of PAA takes place before H_2O_2 reduction (Fig. 2) provides a way to discriminate the two species. These results will provide the basis for the further development of an on-line peroxide sensor.

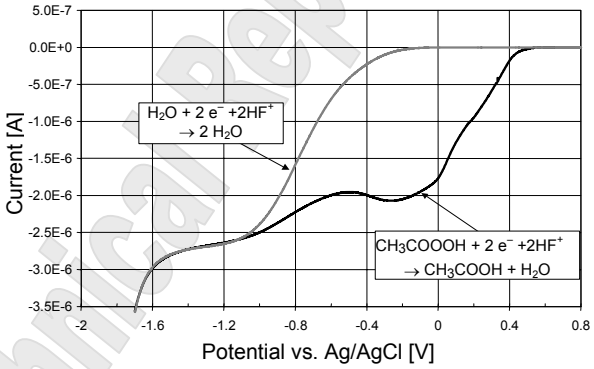

Figure 2: Cyclic voltammetry at gold microdisk array electrode; peracetic acid (3 mM) and hydrogen peroxide(2.5 mM) solutions

Results obtained under an excess of PAA concentration (Fig. 3) demonstrate good sensor linearity in the 0 to 15 ppm concentration range typical for wash liquors.

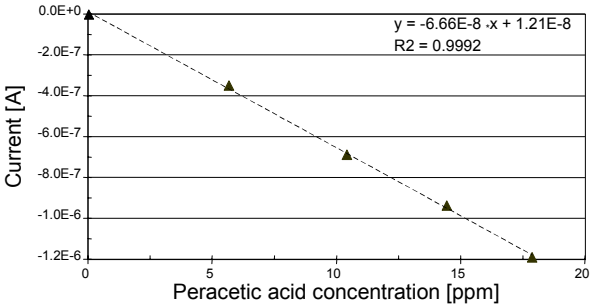

Figure 3: Microelectrode array response to peracetic acid

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[1] M.G.C. Baldry, "The Bactericidal, Fungicidal, and Sporicidal Properties of Hydrogen Peroxide and Peracetic Acid", J. Appl. Bact., 54 (1983) 417

[2] M.I. Awad, C. Harnoode, K. Tokuda, T. Ohsaka,"Simultaneous Electroanalysis of Peroxyacetic Acid and Hydrogen Peroxide", Anal. Chem., 73 (2001) 1839