Generator-Collector Pulse Electroanalysis at "Piranha Junction" Electrodes

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Generator-collector feedback junction electrodes provide the possibility to sense low concentrations of a redox species in solution and could be used for environmental sensing. High sensitivity can be achieved with a small inter-electrode gap and relatively large area electrodes to give high collection efficiency.

Recently it has been shown that high collection efficiencies could be attained through the use of tin doped indium oxide (ITO) plate electrodes in ITO – epoxy – ITO "piranha junctions" [1]. Two ITO coated glass slides were fixed together vis-à-vis with a film of epoxy and the end is dipped into piranha solution to reveal the gap. Inter electrode gap sizes of around 3 μm were typically achieved with the trench between the electrodes having a depth of ca. 60 μm (see Figure 1). This confined environment between the electrodes has the advantage of the majority of the electro-generated species remains within the gap therefore enabling good detection at the collector electrode.

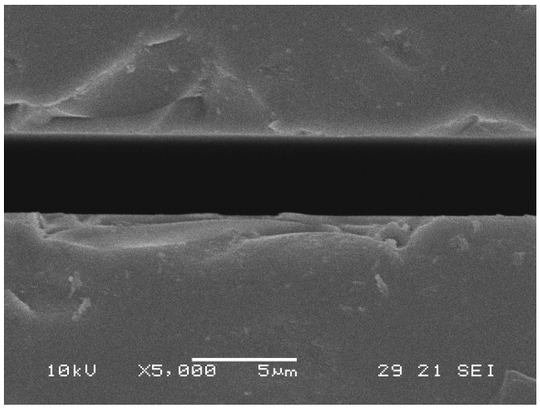

Figure 1. SEM image of the inter-electrode gap between two ITO electrodes in a piranha junction.

Now a wider range of piranha junctions can be produced. Gold – epoxy – gold electrodes were fabricated here using the same method. This relatively simple fabrication technique opens up the possibility of combining different electrode materials for junction electrodes as well as placing absorber materials within the gap for analytical applications.

Pulse electroanalysis with generator-collector junction electrodes has been studied for example for enzyme-free glucose detection. L. Rassaei *et al*. [2] showed that by using normal pulse voltammetry, high pH conditions could be produced locally on one electrode through the reduction of water to produce hydroxide ions, whilst detection was made with the other electrode. As a result "pH-pulses" are applied which lead to the detection of pH-responsive analytes.

Here, pulse electroanalysis at generator-collector junctions is critically assessed. We demonstrate that bipotentiostatic control for short pulses is difficult to achieve. We also show that gold – epoxy – gold piranha junctions have the advantage of a confined trench area where pH can be controlled with normal pulse voltammetry at one electrode whilst detection of analytes such as ammonia is carried out on the second electrode.

[1] S. E. C. Dale, C. E. Hotchen, F. Marken, Electrochim. Acta, *in press*.
[2] L. Rassaei, F. Marken, Anal. Chem. **2010**, *82*, 7063.