Signal-to-Noise Improvement on Electroanalytical Chemistry Using Parallel Array of Microband Electrodes and Application to Flow Injection Coulometry

Hiroki Hayashi

The signal-to-noise (S/N) improvement of electrochemical sensors has attracted a considerable attention. In this study, an attempt was made to demonstrate the potentials of a parallel array of microband electrodes or, in short, a stripe electrode, as an electrochemical transducer.

The potential-step voltammetric behavior of the reduction and oxidation limiting current of hexacyanoferate ions at the stripe electrode has been studied experimentally with reference to their S/N advantage. The voltammetric behavior was well explained by the theoretical equations proposed by M. Senda. The voltammetric current at the stripe electrode approaches the Cottrellian current with increasing sampling-time. Calibration plots were constructed for the concentration range of 0.5 ∼ 45 μM of hexacyanoferate. The slopes and intercepts of the regression line of the plots are discussed in term of the microband width (a^0) and the distance between the centers of microbands (b^0) of the stripe electrodes. The S/N advantage of the stripe electrodes has been shown. The effects of the swelling and smoothness of microband electrodes are discussed.

The stripe electrode was applied to flow-injection coulometry. The rectangular thin layer cells (TLCs) with planar or stripe platinum electrodes set on a basement and of different heights (h = 20 and 33 μm), length (l = 12 and 18 mm) and width (l = 7 mm) were tested. Coulometric yield vs. flow rate plots indicate that there is a maximum flow rate, v^{max}, characteristic of the TLCs used and the substances tested, and that when the flow rate is lower than v^{max} the coulometric yield is always equal to 100% (with errors less than, e.g., 1%); also, the yield is less than 100% when the flow rate is less high. Theory is presented to predict the v^{max} values for each of the TLC, using a planar or stripe electrode. The theoretical vmax values are compared with the experimental results.

The present work represented a significant step toward the high sensitive electroanlysis.