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NOTES ON EXPERIMENTAL TECHNIQUE AND APPARATUS

# Local removal of glass insulation from metal microelectrodes by air-abrasion

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deviations of each isotope are calculated. Any isotopic ratio lying outside five mean deviations from the mean is rejected. Since anomalies in the isotopic composition of a sample are found by comparison with a standard sample run under identical mass spectrometric conditions, provision is made for reading in the standard ratios so that the permil deviations of the sample from the standard can be calculated. Depending on the rate of decay of the beam, corrections for exponential decay or linear approximations to it can be made.

**4. Discussion**

The computational programme is applicable to many isotopic problems in which accurate peak selection is required. A remote teletype located in the laboratory can be used to load the programmes and display the results. Depending on user-demand for the computer, the data from one run can be computed while data from a subsequent run are being collected. This enables an evaluation of the isotopic ratios to be undertaken immediately, so that the amount of additional information required to achieve a particular level of statistical significance can be determined. It also enables such assessments to be made while the sample is still in the spectrometer, thus minimizing the number of time-consuming sample changes.

The elimination of the human element from the data handling process overcomes a source of error inherent in many data collection systems. However, there is a danger that such automation can mask small but significant instrumental errors which may be introduced and remain undetected over a period of time. An efficient checking routine must therefore become an integral part of any on-line system.

In the system described in this paper routine checks were made at regular intervals by printing out data on the parallel printer and comparing this with the corresponding data as processed by the computer. Periodic tests using standardized voltages were made to check the calibration and accuracy of the system as a whole, while rapidly changing voltages were used to test the speed of response of the system. Frequent measurements were also made on standard samples, allowing instrumental faults to be readily detected.

This data processing system was constructed at a time when serious limitations were being imposed on the overall accuracy of measurements because of the laborious and time-consuming nature of the existing data handling techniques. These limitations have now been overcome in such a way that the data can be efficiently collected and accurately presented with a minimum of delay by using a time-sharing computer.

**Acknowledgments**

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# Local removal of glass insulation from metal microelectrodes by air-abrasion

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**Abstract.** The removal of small areas of insulation from glass-insulated platinum–iridium microelectrodes with a jet of abrasive particles is described. The process can be controlled delicately and produces electrodes which minimize mechanical damage to tissues and shunting of the signal when extra-cellular potentials are recorded beneath the surface of conducting fluids.

Wolbarsht, MacNichol and Wagner (1960) described a method of shaping platinum–iridium alloy microelectrodes electrolytically and insulating them with a low working point glass for intra-cellular recording. To provide a conducting region for recording the signal, the glass at the extreme tip of the electrode is ruptured by passing direct current through the electrode while its tip is immersed in a conducting fluid.

This method will remove insulation only from the tips of needle-shaped electrodes; but sometimes an insulated electrode with a conducting region other than at the tip is needed, for example the hook-shaped electrodes often used for extra-cellular recording from nerves. When used uninsulated to record from nerves immersed in tissue fluids or saline, such electrodes shunt much of the signal, but if the nerve is temporarily raised out of the fluid to decrease shunting, it quickly dries unless a moist-chamber is used, which may be inconvenient. Immersing nerves and electrodes in liquid paraffin may also be inconvenient when recordings are made *in vivo*.

The preparation of a glass-insulated hook-electrode from

which a small area of glass is removed is begun by bending into a hook round a drill shank the end of a short 70% Pt–30% Ir alloy wire, 0·01 in. in diameter. The radius of the curve is varied to suit the size of the nerve by varying the drill size.

The hooked part of the wire is narrowed by electrolysis until its diameter has been decreased to one-half to two-thirds, producing a fine hook on a thick shank. The hook is passed through a molten drop of low working point glass suspended from a hot platinum wire, leaving a thin coating of glass on the surface of the wire and a small blob at the tip (Wolbarsht *et al.* 1960).

A small area of glass is removed from inside the hook by abrasion with an air-borne stream of alumina particles from an S. S. White Industrial Airbrasive unit, model G. In suitable operating conditions the process can be controlled very delicately. The electrode is illuminated brightly and viewed through a binocular dissecting microscope while short bursts of Elliott Airbrasive powder no. 5 (particle size 10 $\mu$m) are discharged at it from a nozzle with a rectangular orifice 0·006 in × 0·060 in. (S. S. White part no. 351–1859x) held in the hand with its tip close to the electrode. The machine is best set at low pressures (15–25 lb in$^{-2}$) and at low to medium feed rates (feed control setting 50–70 v). With practice the progress of abrasion can usually be controlled by visual observation at a magnification of about ×50, but if necessary the amount of metal exposed can be determined by measuring the resistance of the electrode from time to time during abrasion. Excess alumina discharged from the nozzle is removed by a vacuum cleaner connected to a suction tube 1¼ in. in diameter with its open end just below the electrode. After abrasion, platinum black can be deposited electrolytically on the exposed metal to improve stability if desired.

As well as recording an increased proportion of the action potentials of immersed nerves, the smooth glass coating and blunt tips of the electrodes make them very easy to position under nerves without damaging the tissues mechanically, particularly when twin electrodes are mounted on one micromanipulator for bipolar recording. The abrasion technique could obviously be useful for local removal of insulation from other types of microelectrodes.

The low working point glass was very kindly produced for me by the Research Department of Pilkington Brothers, Ltd.

**References**

WOLBARSHT, M. L., MACNICHOL, E. F., and WAGNER, H. G., 1960, *Science*, **132**, 1309–10.

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# A method of electrothinning small metal strip specimens for transmission electron microscopy and of detecting the end of the process automatically

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**Abstract.** A method of electrothinning is described together with an apparatus that employs an electrical resistance method to detect the completion of polishing.

In order to prepare specimens for examination by transmission electron microscopy from metal samples available in the form of small strips, typically 0·3 mm × 3 mm × 15 mm in dimension, the following electrothinning technique, due to Bollmann (1958 unpublished), has proved successful. The strip is spot welded or otherwise attached to a backing washer of similar material as shown in figure 1(*a*). Electrothinning of the assembly proceeds by the Bollmann (1956) technique until the strip is just polished away in the middle leaving two pointed tips as in figure 1(*b*). Each tip is generally suitable as a specimen for electron microscopy provided the polishing has been stopped at the right moment.

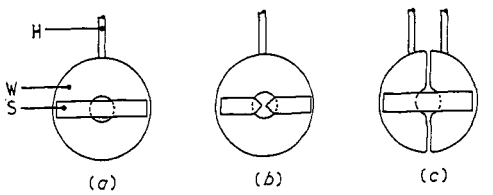


Figure 1. Methods of mounting the specimen. (*a*) The normal method: the specimen S is mounted across the hole in the backing washer W which is supported by the current lead H. (*b*) The appearance after thinning: the two pointed tips of the specimen may be cut off for examination by electron microscopy. (*c*) The specimen mount modified for use with the automatic detection technique.

Detecting the optimum moment to stop polishing can be troublesome when the polishing solution is slow in action as is for example the 150 g $CrO_3$, 800 ml. acetic acid, 12 ml. $H_2O$ solution used for polishing iron alloys, and an automatic detection method is then desirable. Optical methods are not applicable as this particular solution is opaque, and an electrical method is the obvious choice. The supporting washer is now made as shown in figure 1(*c*) with the two halves electrically insulated from each other and rigidly supported so that there is no risk of straining the specimen fixed between them. A simple measurement of the resistance between the two halves of the split washer gives an excellent indication of the moment when the strip just parts, but