LETTERS TO THE EDITOR

PHYSICS

A Time-resolved Spark as a Source for Atomic Absorption Analysis

A HIGH-PRECISION, time-resolved spark which is controlled electronically[1] has been used as a source for the atomic absorption determination of copper, with promising results.

From time-resolved spark investigations the following facts have been ascertained: (*a*) The field strengths and ion concentrations in the spark channel decrease with time. In a spark with a 0·01 farad condenser charged to 20 kV and a discharge duration of about 45 μsec, the ion concentration 10 μsec after initiation of the spark is about 10^{18} ions/cm^3. After approximately 50 μsec the ion concentration has decreased to 10^{17} ions/cm^3. The field strength under those spark conditions changes from about 600 kV/cm to 200 kV/cm (ref. 2) over the same period. (*b*) Pressure broadening appears to be at a maximum during and shortly after the breakdown of the spark gap[3]. (*c*) Self-reversal of resonance lines increases with time. For certain lines, however, the line profiles improve with time[4]. (*d*) For a spark discharge in a point to plane system, with a duration of about 9 μsec, some arc-like and spark lines continue to radiate after the termination of the electrical current[1]. (*e*) An appreciable improvement in line to background intensity ratios of resonance lines may be achieved by increasing the inductance in the spark discharge circuit[5].

The light source used for atomic absorption spectroscopy should give atomic spectral lines with narrow bandwidths[6]. Considering these requirements, it was realized that a spark might be used as a source for atomic absorption analysis if the radiation, after the termination of the electrical current, is used for absorption.

Table 1. EXCITATION CONDITIONS

Type of spark: electronically controlled high-precision spark

Peak voltage	17 kV
Capacitance	6,000 μfarad.
Inductance	residual (5–6μ henry)
Control gap electrodes	tungsten wtih 2 per cent thorium
Control electrode gap	3·6 mm
Analytical electrodes	point to plane top, ¼" spherical bottom, 2½" diameter aluminium disk containing about 0·3 per cent copper
Analytical electrode gap	6·0 mm
Duration of a single discharge	9·3 μsec
Prespark period	10 sec
Exposure period	50 sec
Time-resolved portion	9–11 μsec

If an accurately timed spark with the conditions listed in Table 1 is used, and the radiation restricted to 9–11 μsec after initiation of the spark, the following is further achieved: (1) Doppler-broadening is reduced to a minimum with minimum inductance in the discharge circuit. In this way thermal radiation is restricted. (2) Stark broadening is reduced by at least one order of magnitude accepting the results of Bardócz[2]. (3) Self-reversal of the resonance line is reduced to a low value by using a low copper concentration in an aluminium alloy. (4) Reasonable line to background ratio is obtained[1]. This ratio can be improved by adding inductance for the circuit, but due to the increased thermal excitation, Doppler broadening will increase the line-widths.

To investigate the use of the spark as a source for atomic absorption analysis, the light from the spark was passed through a low-temperature flame into which copper solutions were sprayed. The intensities of the spectral lines were measured with a medium Hilger quartz spectrograph fitted with a direct-reading head[7]. In Table 2 some results of the absorption measurements are given.

Table 2. ATOMIC ABSORPTION RESULTS OBTAINED ON COPPER SOLUTIONS WHEN A SPARK IS USED AS A LIGHT SOURCE

Solution	Line pair 3247 Cu I / 2816 Al II	3247 Cu I / 3066 Al	3247 Cu I / background*
Water	0·786, 0·783†	1·29, 1·26	1·61, 1·65
80 p.p.m. Cu	0·758, 0·756	1·26, 1·26	1·59, 1·63
500 p.p.m. Cu	0·663, 0·660	1·10, 1·13	1·40, 1·45

* Background measured in the region of 4000 Å.
† Results for two exposures are given.

As is to be expected, the method is appreciably less sensitive than conventional methods using a hollow cathode lamp as a source, because of the wider spectral lines. However, the results have shown that a spark may be useful as an atomic light source for certain applications. Further research is being conducted to investigate: the possibility of using complex alloys or powders for multi-element analysis; which elements can be determined simultaneously; what spark conditions will give the most satisfactory results; what concentrations of the alloying elements can be used.

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Electrical Behaviour of Egg Albumen Solutions at Ultra-High Frequencies

FROM previous work[1,2] it is known that egg albumen, in common with other protein solutions, exhibits dielectric dispersion at megacycle frequencies and microwave frequencies due to the relaxation of the protein and water molecules, respectively. The measurements recorded here, however, indicate that there is another small dispersion region occurring at tens and hundreds of megacycles between the two main regions which is similar to the effect reported by Schwan[3] for the case of hæmoglobin.

An 8 per cent solution of egg albumen was prepared by dissolving crystalline egg albumen in conductivity