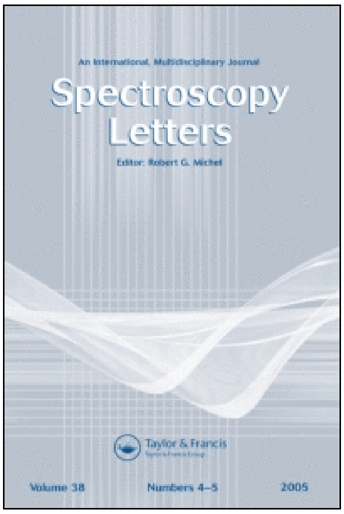

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Use of a Twin-Port Power Divider and Attenuator in the Operation of Electrodeless Discharge Lamps for Multi-Element Atomic Fluorescence Spectrometry

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USE OF A TWIN-PORT POWER DIVIDER AND ATTENUATOR IN THE OPERATION OF ELECTRODELESS DISCHARGE LAMPS FOR MULTI-ELEMENT ATOMIC FLUORESCENCE SPECTROMETRY

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ABSTRACT

The range of the two techniques of multi-element atomic fluorescence spectrometry may be extended by the use of a twin-port power divider to allow two multi-element electrodeless discharge lamps to be operated from a single microwave generator. Various combinations of ¼-wave, ¾-wave resonant cavities and an A-antenna in conjunction with a coaxial attenuator allow lamps of differing excitation requirements to be operated simultaneously.

Earlier papers from this laboratory[1-5] and other papers[6-12] have described the preparation, operation and use in atomic fluorescence spectrometry of several multi-element electrodeless discharge lamps (EDL), the majority of which contain two metallic elements. A major restriction on the construction of these lamps is that to obtain the maximum atomic line emission intensity for all of the elements present in the EDL, the volatilities of the fill materials must be similar. This limits both the combination of elements that can be used together, and the total number of elements that can be combined in a single EDL.

Two rapid-sequential multi-element methods of analysis based on atomic fluorescence spectrometry have been reported, for which multi-element spectral sources are desirable: wavelength scanning atomic fluorescence[6,7]; and time-resolved atomic fluorescence spectrometry, with electrothermal atomizers[11,13,14]. The advantages of the wavelength scanning technique increase with the number of elements that can be determined in a single scan. The time-resolved method requires that the elements to be determined should have reasonably different volatilities or atomization temperatures. Thus the limitations on the construction of multi-element EDLs also seem to restrict their suitability for use to the greatest advantage in these analytical procedures. It is, therefore, desirable to be able to operate several EDLs simultaneously.

A twin-port power divider for the simultaneous operation of two EDLs from one microwave generator has been reported[6,7,12-14]. However, in all of that work both of the lamps were operated at the same microwave power and in identical coupling devices, which limits the number of different types of EDLs that can be operated together. A survey of the literature on the use of EDLs in atomic spectrometry shows that for unmodulated operation with a resonant cavity most have optimal operating powers in the range 50-60 W, although an important group are best operated at 15-30 W.

This paper describes an examination of the use of a twin-port power divider for the simultaneous operation of two EDLs with the object of extending the range of independent operating conditions simultaneously available at each port, and hence the range of different types of EDL suitable for simultaneous operation at their optimal powers in multi-element atomic fluorescence analysis.

INSTRUMENTATION

A block diagram of the instrumental arrangement employed in this work is given in Figure 1. Microwave power was supplied at 2450±25 MHz from a Microtron 200 microwave generator (Electro-Medical Supplies Ltd., Wantage, U.K., Model 2000L) fitted with a 285 Hz modulator unit (EMS Model 3005L), *via* a 45 cm length of coaxial cable to a twin-port power divider (EMS Model 4000L), then *via* two 2.74 m lengths of coaxial cable to two reflected

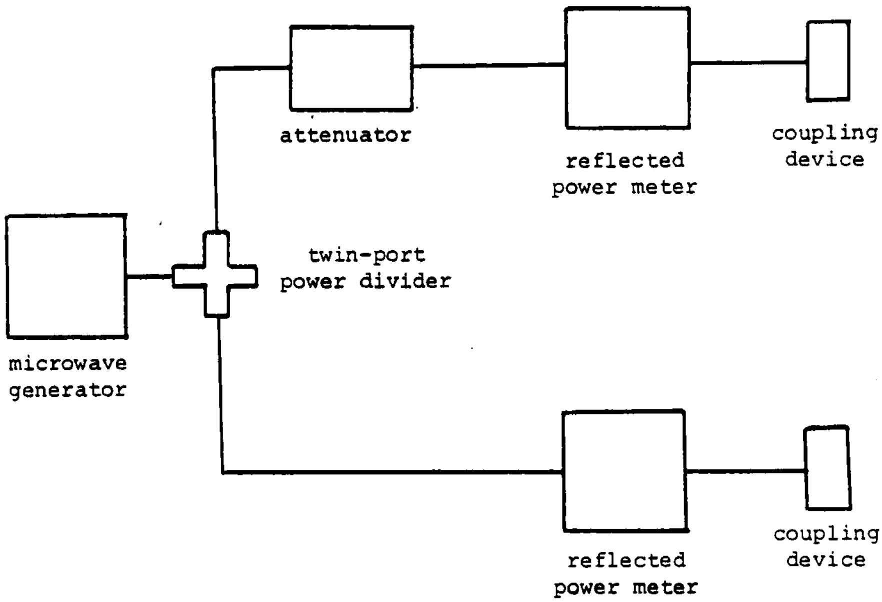

FIG. 1 Instrumental arrangement used with twin-port power divider

power meters (EMS Model 150S), and finally to the coupling devices *via* two 1.37 m lengths of coaxial cable. In some experiments a 6db attenuator (EMS Model 4003L) was inserted in one arm between the power divider and the reflected power meter, using two 1.37 m lengths of coaxial cable for the connections. The microwave coupling devices used were $\frac{3}{4}$-wave resonant cavities (EMS Model 210L), $\frac{1}{4}$-wave resonant cavities (EMS Model 214L) and an A-type antenna (Raytheon Inc., U.S.A.). The EDLs employed were prepared by the general procedure described elsewhere[15]. The spectral output of the EDL was monitored using a Varian-

Techtron AA4 atomic absorption spectrometer tuned to the wavelength of the appropriate emission line.

RESULTS AND DISCUSSION

The resonance line emission intensities of two identical EDLs and the reflected powers showed that an equal microwave power, equivalent to 50% of that indicated on the meter of the microwave generator, was being coupled to each EDL when the coupling devices were two ¾-wave resonant cavities, two ¼-wave resonant cavities, or one ¾-wave and one ¼-wave resonant cavity. However, when the A-type antenna was employed in conjunction with either type of resonant cavity, a greater microwave power was available for coupling to the EDL in the antenna than to that in the resonant cavity, as shown by incident power and line-emission intensity plots and by a smaller reflected power with the antenna than with the resonant cavity. At an indicated total incident power of 75 W of the generator, the difference in the two reflected powers was as much as 20 W. Since the applied power necessary to operate EDLs in antenna is normally greater than that for the same EDL when operated with a resonant cavity, it would appear that the combination of an antenna and a resonant cavity for the simultaneous operation of EDLs in conjunction with a twin-port power divider would not be expected to increase the range of different types of EDL that can be used together.

The use of an attenuator, which reduces the microwave power to an EDL, has been described previously[16]. A 6db attenuator was inserted in one arm from the two-port power divider, as indicated in Figure 1. Incident power and intensity plots for various EDLs showed that an attenuator reduced the power delivered to that EDL to 25% of that delivered to the EDL in the other arm. This was found to be effective for all combinations of the resonant cavities. Thus an EDL with an optimal operating power of 12 W could be used simultaneously with another EDL with an optimal operating power of 50 W. Attenuators of other ratings would increase the power ranges that could be used together and hence the number of different types of EDL that can be used simultaneously for multi-element atomic fluorescence spectrometry.

CONCLUSION

The operation of pairs of EDLs with a two-port power divider in conjunction with an attenuator and the two types of resonant cavity allows almost any combination of EDLs to be operated simultaneously together at their optimal operating powers. This mode of operation, and the variety of multi-element EDLs available provides a wide range of multi-element spectral source combinations suitable for use in multi-element atomic fluorescence analysis.

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