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Simultaneous Light-Absorption and Emission Measurements behind a Shock Wave*

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IN connection with current extensive studies on the rate of carbon formation behind weak shocks in acetylene, it proved to be desirable to obtain simultaneous light-absorption and emission data. The absorption experiments are complicated because of intense emitted radiation associated with chemical reaction behind the shock front. One method for separating the emitted component from the transmitted light involves the use of carefully matched photocells and subtracting the emitted radiation from the sum of the transmitted and emitted radiation.[1] Another method involves the use of chopped light for the absorption measurements. However, the chopping rate places an upper limit on the rates of reaction that can be studied. A Kerr cell[2] using nitrobenzene can be used to modulate the light at frequencies greater than 10 megacycles without appreciable attenuation and is therefore suitable for the study of reaction rates behind weak shocks.

The use of a Kerr cell[3] made it possible to study simultaneously emission and absorption during the decomposition of acetylene behind weak shocks. The light source was a General Electric Type 524 xenon lamp, with a peak intensity of 50 million lumens when pulsed for 1 millisecond. This lamp was operated so that its peak radiation lasted about 400 microseconds. The lamp was fired by discharging a capacitor through a thyratron tube which was suitably delayed so that the peak intensity of the xenon source occurred during the time that the shock passed the observation station in the shock tube. The light from the xenon source passed through the Kerr cell and then through the shock tube. Both the emitted light and the transmitted modulated light (with or without the use of a suitable monochromator) may be detected on a single photomultiplier tube whose output is then displayed on an oscilloscope. The ac component of the phototube output represents the transmitted light, the dc component corresponds directly to the emitted light.[4]

Another possible use of the Kerr cell involves the use of a Kerr-cell modulated prism as beam deviator followed by a monochromator.[5] This combination may be used as a high-speed scanning monochromator with time resolution sufficient for studies behind weak shocks.

It is felt that the successful development of new high-speed recording and scanning devices will facilitate full utilization of the potentials of the shock tube for quantitative high-temperature gas dynamic investigations.

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[1] Experiments of this type have been carried out by Mr. W. Hooker of our staff while he was associated with the General Electric Company.

[2] The use of the Kerr cell was suggested by Dr. N. Davidson.

[3] The author is indebted to Dr. A. Ellis for the use of his Kerr cell.

[4] This arrangement permits several obvious extensions. For example, the emitted radiation in several distinct wavelength regions can be chopped at different frequencies and recorded simultaneously on a single photoelectric receiver.

[5] This method of approach was suggested by Dr. S. S. Penner and has been studied by Dr. V. Vali of the Lockheed Aircraft Company.