

Generation and Measurement of Uv Light Pulse in the Nanosecond and Sub-nanosecond Region

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Uv light pulses of duration of 10^{-9} seconds or less are an important tool in the study of very fast photochemical processes. Hitherto, lamps possessing the required characteristics did not exist. The best available lamps suffered from after-pulses of high firing voltages, were erratic in operation and actually had characteristic times much exceeding the nanosecond requirement.

A lamp has now been developed which produces a uv pulse of a desirable shape, namely a half-width of 0.4 nsec and rise and decay times of 0.3 nsec and 0.5 nsec respectively measured between 10% and 90% full intensity. The light output is estimated to be about 10^6 photons per 0.003 steradian. These light pulse characteristics are obtained with a high pressure (20atm) hydrogen lamp with specially shaped fixed electrodes which are kept covered with a mercury film during operation; cf. Figure 1. To achieve these desirable pulse characteristics the lamp and associated electrical elements must be coaxially mounted.

For measurement of the shape of the light pulse, an electronic sampling technique is used because common light-to-electric current converters have too small a band width to permit undistorted conversion. The main component of the sampling equipment is an image converter which permits measurement of the average light intensity of a large number of light pulses in the very narrow time intervals at preset points on the light pulse curve.^{1,2} The light pulse curve is easily constructed from such average values. The requirement of precise timing of the detection system and the light pulses is met by use of the electric pulse in the lamp as a trigger for the detection system. Incidentally, the electric pulse itself has characteristics which approximate in form the light pulse curve. In convenient operation, the electric pulse output is 1200 volts maximum. Because the delay in the electric pulse control circuit is less than the delay experienced by the electrons in the image converter, it is actually possible to use the electric pulse to trigger observation before the light signal reaches the critical parts of the image converter; cf. Figure 2.

The principal utility of a lamp of the type described is in studies of the behavior of directly excited states. In radiation chemistry, energy ultimately localized in a small-concentration solute has been originally deposited in a system which, in toto, greatly exceeds in quantity the relatively few molecules under direct study. One consequence is that interpretation of the kinetic behavior is obfuscated by a number of unknown factors. Direct excitation of a solute (by light which can affect only that solute directly) can be studied, so far as

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immediate effects are concerned, in terms of the luminescence behavior of that solute if it is properly chosen. Because of the intensity of the lamp herein described, it is quite reasonable to select only the limited light which can affect only the solute, and not the solvent, if it be properly chosen. A combination of filters properly selected can ensure that the fluorescence of the single species under study is the only one which can affect the apparatus used for observation of decay times of that fluorescence. Some rough, but significant, preliminary experiments have been performed.

Literature Cited

1. Dreeskamp, H., and M. Burton. 1959. *Phys. Rev. Letters*, 2, 45.
2. Ghosh, A., and M. Burton. 1961. *Rev. Sci. Instr.* 32:304.