A new flash-photolysis instrument specially designed to generate hydrated electrons and for study of their reactions is described in detail in the reference. With its unique, three-dimensional, multiple-reflection cell and its capacity to produce up to $10^{-7} Me_{aq}$ in a single 40-µsec light pulse, this instrument provides adequate sensitivity for determination of $e_{aq}$ rate constants and for use in analytical chemistry. With the instrument, less than $10^{-9} Me_{aq}$ can be detected.

Hydrated electrons are generated in a $H_2$-saturated alkaline solution by a flash of ultraviolet light. The well-established reactions producing $e_{aq}$ are

$$\text{OH}^- + h\nu \rightarrow \text{OH} + e_{aq} \quad (1)$$

$$\text{OH} + H_2 \rightarrow H_2O + H \quad (2)$$

$$H + \text{OH}^- \rightarrow e_{aq} \quad (3)$$

Note that each light quantum, effective in reaction-1, eventually produces a second $e_{aq}$ via reactions 2 and 3.
3; but scavengers such as O₂, when present even in submicromolar concentrations, profoundly affects its formation and decay. For their elimination the solutions are preirradiated with a second ultraviolet mercury lamp. After cleanup, the syringe-handling technique is used to add the scavengers at submicromolar levels. During preirradiation and after the injection of samples, the solution in the cell is mixed by a small, glass-encased, iron rod that is activated by a solenoid receiving repetitive pulses from a pulse-generating circuit.

The apparatus shown consists of a xenon flash lamp, a mercury ultraviolet lamp, a suprasil (R) quartz irradiation cell, a tungsten lamp, an optical system, red filters, a photomultiplier, and an oscilloscope.

The hydrated-electron concentration is followed by monitoring of the light-transmission of the solution at 700 nm near its optical-absorption maximum. At this wavelength its molar extinction coefficient is $1.85 \times 10^4 \text{ M}^{-1} \text{ cm}^{-1}$. For increased sensitivity the narrow analyzing light beam from a tungsten lamp is passed through the cell seven times. Next the light passes through a red-filter combination and then into the cathode of a photomultiplier tube. The transient absorption signal is finally displayed on an oscilloscope and recorded.

Reference:

Notes:
1. This information may interest researchers studying hydrated electrons.
2. Inquiries concerning this innovation may be directed to:
   Office of Industrial Cooperation
   Argonne National Laboratory
   9700 South Cass Avenue
   Argonne, Illinois 60439

Reference: B70-10036
Source: K. Schmidt, E. Hart
Chemistry Division
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Patent status:
Inquiries concerning rights to commercial use of this innovation may be made to:
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