Two Photon Ionization of Liquid Tetramethyl Silane

H. Böttcher and W. F. Schmidt

Hahn-Meitner-Institut für Kernforschung Berlin, GmbH, Bereich Strahlenchemie, Berlin

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The photoconductivity of neat liquid tetramethyl silane subjected to an intense UV laser flash was studied as a function of laser power. Charge carrier generation was found to proceed via double photon ionization.

Ionization of non-polar liquids by high energy radiation has been studied for many years with the aim of understanding the primary processes of interaction of radiation with condensed matter [1]. Radiation induced conductivity measurements, scavenging studies and pulse radiolysis investigations have elucidated many details of these processes.

With the availability of VUV-light sources (as synchrotron light source) and powerful lasers the ionization process of solvent molecules or solute molecules in non-polar liquids has become amenable to observation. Recently we reported results of one photon ionization of neat tetramethyl silane at room temperature studied by measurement of the photoconductivity induced by irradiation with light from a synchrotron source [2]. The ionization threshold was determined to be 8.1 eV. Casanovas et al. [3] confirmed this value and reported also some values for other hydrocarbon liquids.

With the availability of strong laser sources in the near UV which produce photons of 3.5–6.5 eV photoionization of non-polar liquids by double photon absorption becomes feasible.

Here we wish to report the first results of photoconductivity measurements of tetramethyl silane at 22 °C which was illuminated with light from an excimer laser.

The liquid was contained in a conductivity cell with quartz windows and the light beam passed the test volume parallel to the electrodes (Figure 1). The light source was the pulsed laser EMG 500 from Lambda Physics. The time profile of the pulse was monitored with a fast vacuum photodiode. It exhibited a half width of 6 ns.

The energy per pulse was measured with a laser energy meter (Laser precision, model LP 152).

The variation in time of the photocurrent was followed with an oscilloscope. Figure 2 shows a typical oscillogram. The almost linear decay of the current indicates that the ionization occurred in the bulk of the liquid. The laser intensity was varied over almost two orders of magnitude and the corresponding photocurrent signals were integrated.

Reprint requests to Dr. W. F. Schmidt, Hahn-Meitner-Institut für Kernforschung, Bereich Strahlenchemie, Glienickerstr. 100, 1000-Berlin-Wannsee.

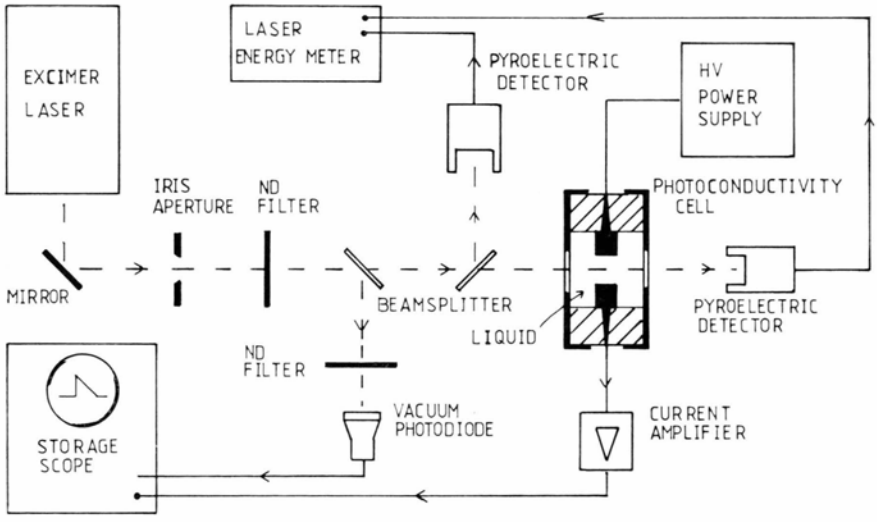

Fig. 1. Schematic of experimental set-up for photoconductivity measurements.

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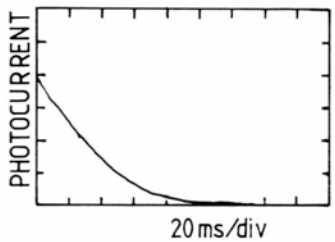

Fig. 2. Variation in time of the photo current in tetramethyl-silane after a flash of UV light.

Figure 3 shows the result in double logarithmic presentation. The slope of the curve is two, which indicates that a two photon-process took place. The deviation at very high intensities is due to the fact that such a high concentration of charge carriers is produced that with the applied field strength of 6 kV cm^{-1}, volume recombination cannot be neglected.

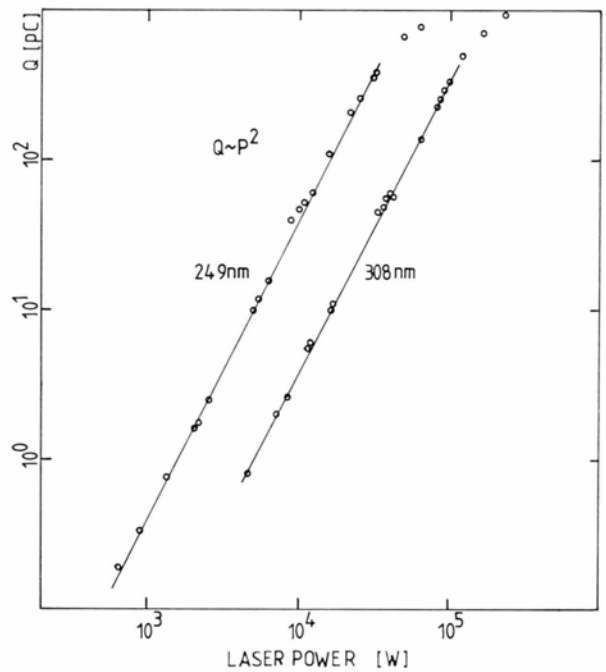

Fig. 3. Integrated photo current of tetramethyl silane as a function of the laser power.

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