Photocondensation of iodine

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We have observed, for the first time, photocondensation of iodine vapor in an intense beam of visible light. Differences are observed between the behavior of the photocondensate and an ordinary melt. The results of a qualitative investigation of the phenomenon are described.

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It was suggested in[1] that a first-order phase transition can be initiated by light in simple one-component systems. This idea was experimentally confirmed for a number of molecular systems in[2–4]. Photocondensation phenomena were observed and investigated in initially unsaturated vapors, as well as photocrystallization in

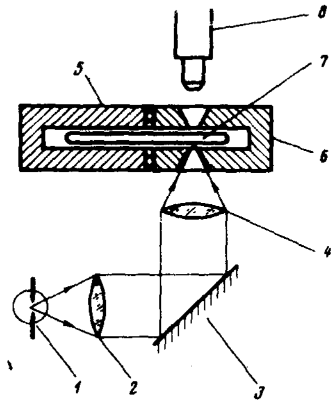

FIG. 1. Experimental setup for the observation of the photocondensation of iodine: 1—mercury lamp (DRSh-100-2), 2—collector lens, 3—mirror, 4—condenser lens, 5—thermostat set at temperature T_1, 6—thermostat at temperature T_2, 7—glass tube with investigated substance, 8—microscope.

unsaturated vapors, solutions, or superheated melts of molecular compounds.

After searching for systems convenient from the model point of view, we succeeded in observing the photocondensation of iodine vapor in an intense beam of visible light. The diagram of the setup employed is shown in Fig. 1. Radiation from a mercury lamp (type DRSh-100-2) was focused by lenses 2 and 4 and by mirror 3 onto the lower surface of an evacuated glass tube 7 of 3 mm diameter, containing the investigated substance. The left half of the tube was placed in thermostat 5 and kept at temperature T_1, while the right side was placed in thermostat 6 with temperature T_2. Observation of the illuminated section of the tube was carried out with the aid of microscope 8 at a magnification 50—100. The condition $T_1 \leq T_2$ was always satisfied, and thus the pressure of the unsaturated iodine vapor in the tube was determined by the temperature of the left-hand thermostat.

It was observed in this setup that in the temperature interval 180—360 °C the radiation caused condensation of the iodine vapor into a drop at the center of the beam. The photocondensate drops have the following unusual properties:

1. When the light beam moves over the surface of the tube, the photocondensate drop follows the beam and tends to occupy a position in the focus of the beam. Drops of an ordinary melt are rapidly evaporated in the light beam because of the appreciable local rise in temperature (Fig. 2).

2. The photocondensation process begins in unsaturated vapor, but the actual value of ΔT could not be established, owing to the appreciable but undetermined value of the heating of the melt drops in the light beam. Photoexcitation impedes the evaporation of the condensate drop in unsaturated iodine vapor up to $\Delta T = 30$ to 50 °C, where $\Delta T = T_2 - T_1$.

3. When the light intensity is changed, the curvature of the surface of the photocondensate drop changes strongly, thus indicating that photoexcitation affects the value of the surface tension. When the beam intensity is modulate, the drop "breathes" at the appropriate frequency. This phenomenon can be called a photocapillary effect.

4. The phoeocondensation process is initiated predominantly by photoexcitation of a thin layer of the iodine melt. When a drop of an ordinary melt is illuminated, small droplets of photocondensate are produced on the drop boundary and start to move into the center of the beam and merge with the main photocondensate drop. Drops of an ordinary melt "go out" of the light beam (Fig. 3).

It was established that the photocondensation of the iodine is most effective in red light at $\lambda > 600$ nm. This

FIG. 2. Displacement of photocondensate drop following displacement of the light beam, magnification ~ 70×.

FIG. 3. Photocondensation of iodine in light beam. Magnification ~ 70×.

is obviously due to the fact that the excitation of the iodine molecules is most effective on the long-wave edge of the absorption band, whereas in the remaining part of the absorption band it is the thermal effect which predominates.

Our observations confirm the existence of a general effect of the shift of the phase-equilibrium point under the influence of photoexcitation in liquid-vapor systems.[4]

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