Study of CdS Evaporation Kinetics by Laser Spectroscopy

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In this study of evaporation kinetics, we use the thermal dissociation of CdS crystal with laser resonant step photoionization to form Cd atoms. The choice of CdS crystal was stipulated by its thermal properties, with respect to sublimating substances. At relatively low temperatures intensive evaporation takes place without melting.

An atomic beam is created by the thermal heating of CdS in a vacuum *($p=10^{-5}$ torr)*. Upon heating of the CdS crystal it is dissociated on neutral Cd atoms and on molecules S_2 and S_3. The flow of Cd atoms and molecules formed as the beam is irradiated by radiation of three dye lasers and photoionizates Cd on the following scheme:

$$5s^1S_0 \xrightarrow{\lambda_1=326{,}1\text{нм}} 5p^3P_1 \xrightarrow{\lambda_2=479{,}9\text{нм}} 6s^3S_1 \xrightarrow{\lambda_3=488{,}1\text{нм}} 17p^3P_2 + (\varepsilon = 12\text{kV/sm}) \rightarrow Cd^+ + e^-$$

The study of CdS evaporation kinetics was carried out by detection of Cd photoions in the temperature range of 475 to 950 K. As the degree of the evaporation rate of CdS is the corresponding photoionic signal of Cd atoms on output of laser photoionisational spectrometer. The photoionic signal at the evaporation of CdS mass m=73 mg at temperature 943 K had a time of evaporation of 4200s. The evaporation rate was determined by formula:

$$\theta = m / \chi A_s t = 5{,}834 \cdot 10^{-2} \left(M / T\right)^{1/2} \cdot p$$

where $\chi = 3l/8r = 2{,}5$ is a correction factor, A_s the area of the atomizer channel, t the time of evaporation, m the mass of Cd, p the vapor pressure of CdS, and M the molar mass of CdS.

Experimental data on the isothermal evaporation of CdS allow us to make the calculation of evaporation rate *$\Theta=5.539ï10^{-4}$ g/см^{2}s* and saturated vapor pressure *$p=1.078ï10^{-2}$ torr.* The dependence of pressure of saturated vapor of CdS versus temperature in region of 585 to 950 K can be presented by the empirical formula:

$$\log p = (14{,}110 \pm 0{,}036) - (12360 \pm 100) / \cdot T \quad - 0{,}99 \log T$$

The observed temperature dependence of pressure usually is extrapolated to the region of high temperatures, where the temperature dependence of pressure is estimated from independent measurements. By such a method one can find the vapor pressure curve for a wide range from 10^3 to 10^{-10} torr.