GENERATION SPECTRUM OF A CHEMICAL LASER USING A MIXTURE OF H_2 AND Cl_2

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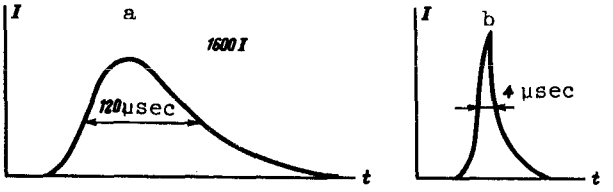
The use of exothermal reactions for the development of chemical lasers is quite promising at present.

An experimental paper by Kasper and Pimental [1] describes generation in a mixture of H_2 and Cl_2 gases at the HCl vibrational transitions. The generation spectrum was related to transitions between the levels v = 1 and v = 0, and was attributed to the presence of partial inversion at the vibrational-rotational levels.

In early 1968 we also investigated lasing by this mixture. The experimental setup was similar to that used in [1]. One of the typical time patterns of the lasing and of the pump pulses is shown in the figure.



a) Time dependence of the pump pulse, b) time dependence of the 2652 cm^{-1} generation line (15 Torr Cl_2, 40 Torr H_2, T = 300°K).

Unlike the results of [1], where the generated radiation was connected with the vibrational transitions v=1 → v=0, our experiment has shown that the emission can be identified with the transition 2 → 1. This is important for the estimate of the efficiency of the elementary act $H + Cl_2 = HCl^+ + Cl$, in other words, of that fraction of the energy which is released during the course of the reaction and is stored in the oscillatory reservoir and can be used in principle to obtain generation.

Polanyi [2] investigated the energy distribution of the HCl molecules obtained as a result of the elementary act, and showed that total inversion occurs in the vibrational transitions v = 2 → v = 1 and v = 3 → v = 2; he could not understand why this inversion could not be realized in [1]. To explain the results of [1] it was necessary to assume too rapid a process of establishment of the Boltzmann distribution over the vibrational levels. Observation of generation at the transition v = 2 → v = 1 eliminates this contradiction and is of importance for the understanding of the kinetics of inversion during the course of the chemical reaction between the hydrogen and the chlorine.

[1] J. V. V. Kasper and G. G. Pimentel, Phys. Rev. Lett. 14, 352 (1965).
[2] J. C. Polanyi, J. Chem. Phys. 34, 347 (1961).

SURFACE EFFECTS IN A STRONG MAGNETIC FIELD

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There are two well-known types of skin effect: normal, when the skin-layer depth δ is large compared with the mean free path ℓ of the charges, and anomalous when $\delta \ll \ell$. In either