

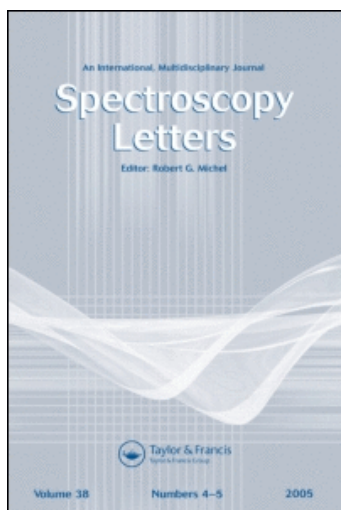
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HgCl (B-X) CHEMILUMINESCENCE FROM ALKALI ATOM - HgCl₂
REACTIONS

Key words: Mercury Halides, Chemiluminescence

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ABSTRACT

Laser action on the $B^2\Sigma^+_{1/2} \rightarrow X^2\Sigma^+_{1/2}$ band of HgCl at 557.6 nm ($v'=0 \rightarrow v''=22$) has previously been achieved under a variety of electronic and optical excitation mechanisms. This letter describes a chemical mechanism for producing excited HgCl. We report on the gas phase reaction between alkali atoms (K, Rb, and Cs) and HgCl₂ which produces HgCl (B-X) emission.

INTRODUCTION

Mercury monohalides are proven active media for gas lasers that emit in the visible spectrum. In particular, the HgCl ($B^2\Sigma-X^2\Sigma$) laser, at 557.6 nm, has been the

subject of considerable theoretical and experimental research¹. Production of $\text{HgCl}^* \text{B}^2\Sigma$ has been achieved by several means, for example, e-beam excitation of rare-gas mixtures containing Hg and CCl_4 ², electric discharge dissociation of HgCl_2 ¹, laser induced chemiluminescence of $\text{Hg}/\text{Cl}_2/\text{Ar}$ mixtures³, and photodissociation of HgCl_2 ^{4,5}.

In this letter we report the observation of visible chemiluminescence from $\text{B}^2\Sigma\text{-X}^2\Sigma$ transitions in HgCl produced in gas phase reactions between alkali atoms (K, Rb, and Cs) and HgCl_2 .

EXPERIMENTAL METHOD

In our experiments, the alkali metal was distilled into a 300 ml Pyrex cell connected to a vacuum system. The cell was heated to produce an alkali atom vapor pressure in the range 10^{-3} - 1 Torr. A side arm containing HgCl_2 was then heated to drive HgCl_2 vapor into the reaction cell. Chemiluminescence was observed and recorded with an optical multichannel analyser.

RESULTS

Fig. 1 shows a spectrum for the $\text{K} + \text{HgCl}_2$ reaction. Except for the alkali atom emission lines, the same spectrum was obtained for reactions with Cs and Rb. The

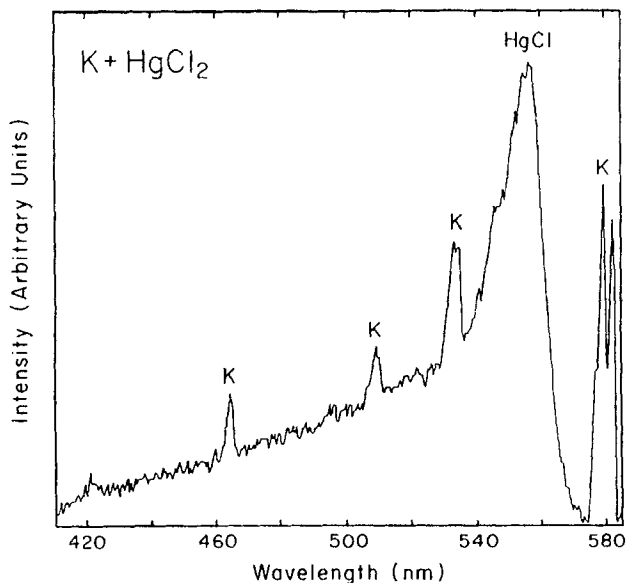


FIG.1 The spectrum of HgCl (B→X) emission from the reaction $K + HgCl_2$.

broad continuum peaking around 557 nm is the complex spectrum for the B-X band of $HgCl^4$.

Based on the bond strengths for $HgCl-Cl^5$ and $M-Cl$ (M = alkali atom)⁶, the reaction $HgCl_2 + M \rightarrow HgCl + MCl$ is approximately 0.9 eV exothermic, 2 eV less than is necessary to excite the B-state of $HgCl^7$. Therefore, the production and excitation of $HgCl$ is not a simple one step stripping reaction. This is further verified by the fact that a few Torr of Ar gas in the reaction cell quenched the $HgCl$ emission but not the reaction or

alkali atom emission. We therefore conclude that the HgCl is probably excited to the B state by collisions with vibrationally excited MCl molecules produced during the stripping reactions.

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