Discharge excited metal excimer systems

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Metal excimers have been predicted to be efficient visible laser candidates for many years. However, no difinitive gain measurement on these systems has ever been performed because of their difficult experimental conditions. Recently, we constructed a pure quartz-molybdenum transverse discharge cell to study Tl-Hg and other metal excimers. The discharge tube design was guided by two fundamental considerations: first, the formation of metal excimers depends on three body recombination processes which suggests the necessity of high pressure; secondly, reasonable metal vapor density requires fairly high operating temperature (~1000 °C). A long cathode was made of molybdenum and profiled according to the Rogowski criteria. Preionization sparks were placed behind a molybdenum screen anode. The entire quartz discharge tube was sealed off and heated in a pressurized oven to counterbalance the pressure within the discharge cell. We have obtained a stable diffuse discharge of dimension $0.5 \times 1 \times 10$ cm^3 in Tl-Hg mixtures at [Hg] $= 3 \times 10^{19}$ cm^{-3} and [Tl] $= 3 \times 10^{16}$ cm^{-3} with an E/N $= 2 \times 10^{-16}$ V cm^2. Emission of this discharge was dominated by Tl* ($7^2S_{\frac{1}{2}}$) 535 nm and TlHg* (B) 459 nm and 656 nm. The excimer excitation processes were due mainly to the transfer of energy from Hg_2* to the Tl and the rate coefficient for the reaction $Hg_2^* + Tl \rightarrow TlHg^*$ (B) + Hg was measured to be 1.8×10^{-10} cm^{-3} sec^{-1}. No transient gain at the peak of the TlHg* band was observed; on the contrary, strong absorptions from Hg_2* and TlHg (X) were detected. To reduce Hg_2* absorption, the discharge of Tl-Hg mixtures at higher buffer gas pressures and reduced Hg densities will be discussed and the use of the same discharge scheme with other metal excimer systems will also be presented.

放电激励的金属准分子系统

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金属准分子被预言为高效率可见光激光器候选者已有多年。但因实验条件困难，对这些系统还没有进行过确定的增益测量。近来，我们制造了一个研究 TlHg 及其它金属准分子的纯石英-钼横向放电管。放电管设计受两项基本考虑支配：第一，金属准分子的形成取决于三体复合过程，这意味着需要高气压；第二，适当的金属蒸气密度要求相当高的工作温度(~1000°C)。用钼制成一个长阴极，其外型是按照 Rogowski 判据设计的。在一个钼屏阳极后面放置预电离火花隙。整个石英放电管是密封的，并在一个与放电管内压力平衡的高压炉内加热。我们已在 Tl-Hg 混合气中，当 $[Hg]=3\times10^{19}$厘米$^{-3}$，$[Tl]=3\times10^{16}$厘米$^{-3}$，$E/N=2\times10^{-16}$伏厘米^{2}时，获得了体积为$0.5\times1\times10$厘米^{3}的稳定扩散型放电。这种放电的发射以 Tl* ($7^2S_{\frac{1}{2}}$)的535毫微米及 TlHg*(B) 的 459 毫微米及 656 毫微米为主。准分子激发过程主要由 Hg_2* 向 Tl 的能量转移而引起。测得反应 $Hg_2^*+Tl\longrightarrow TeHg^*(B)+Hg$ 的速率系数为1.8×10^{-10}厘米$^{-3}$秒$^{-1}$。在 TlHg* 谱带的峰值处没有观察到瞬时增益；反之，从 Hg_2* 和 TlHg(X)探测到强吸收。为减小 Hg_2* 的吸收，对于采用较高气压的缓冲气体及较低汞密度的 Tl-Hg 混合气体进行讨论。并介绍了利用同样放电管配置其它金属准分子的系统。