Decay dynamics from the $E \, 0_g^+$ ion-pair state of $I_2$

(Tokyo Univ. of Sci.) Shoma Hoshino, Mitsunori Araki, and Koichi Tsukiyama

Introduction Amplified spontaneous emission (ASE), as a powerful probe of decay dynamics, is radiation initially triggered by spontaneous emission and then amplified by stimulated emission as it passes through a medium having a population inversion. Two research groups reported the possibility of far infrared (FIR) ASE from the $E \, 0_g^+$ ion-pair states of $I_2$[1, 2]. Recently we reported infrared ASE from the $f \, 0_g^+$ ion-pair states of $I_2$[3]. In this work, we succeeded to detect FIR stimulated emission from the $E \, 0_g^+$ ion-pair state of $I_2$ directly.

The decay process between the $E \, 0_g^+$ and $D \, 0_u^+$ states will be discussed.

Experiment The $E \, 0_g^+$ ion-pair state was excited via the $B \, 0_u^+ (v_B = 19)$ valence state by using an optical-optical double resonance technique. The pump and probe lasers were set at ~ 562 nm and 420 – 425 nm, respectively. The outputs of the two lasers were temporally and spatially overlapped in a 15 cm stainless steel cell with $I_2$ at room temperature. The dispersed spectra of the FIR stimulated emission along the laser optical axis and the UV emission perpendicular to the direction of the laser optical axis were measured with a monochromater.

Results and Discussion The strong UV emission from the $D \, 0_u^+ (v_D = 0)$ state was observed when the $E \, 0_g^+ (v_E = 0)$ state was excited (Fig. 1a, $D \rightarrow X$). This suggests the population transfer by the $E \, 0_g^+ \rightarrow D \, 0_u^+$ FIR stimulated emission process. A part of the dispersed FIR stimulated emission from the $v_E = 0$ level in the $E \, 0_g^+$ state to the $v_D = 0$ level in the $D \, 0_u^+$ state was shown in Fig. 2. However, the emission from the $D \, 0_u^+$ state consists not only of the strong UV emission from the $v_D = 0$ level but also of the weak UV emission from the $v_D = 1, 2, \text{ and } 3$ levels. We measured the pressure dependence of the UV emission with Ar gas. With increasing pressure the UV emission from the $v_D = 0$ level decreased rapidly while that from the $v_D = 1, 2, \text{ and } 3$ levels showed no considerable change. Accordingly, we concluded that the $E \, 0_g^+ \rightarrow D \, 0_u^+$ decay process involves the two pathways: FIR stimulated emission of $v_E = 0 \rightarrow v_D = 0$ and the collisional transfer of $v_E = 0 \rightarrow v_D = 1, 2, \text{ and } 3$.

Reference

Fig. 1. The dispersed emission spectrum by excitation of the $E \, 0_g^+ (v_E = 0)$ state at (a) 26 Pa and (b) $7.0 \times 10^2$ Pa.

Fig. 2. The dispersed FIR stimulated emission spectrum from the $v_E = 0$ level of the $E \, 0_g^+$ state.