레이저 여기된 기체분자들의 차가운 표면 응고저지 현상
Cold Wall Condensation Retardation of Laser Excited Gaseous Molecules

김재우*, 정도영*, Jeff W. Eerkens**, and William H. Miller**
*한국원자력연구소/양자광학기술개발팀, **CRISLA Lab/University of Missouri-Columbia
kimj@kaeri.re.kr

I. Introduction

The gaseous molecular condensation retardation by laser excitation has been known, but with limited success. Condensation inhibition between the gas phase molecules by laser excitation was clearly shown in many experiments.[(1)-(2)] However, surface condensation inhibition of the excited molecules has been controversial for the last several decades.[(3)-(4)] In 1994, S. J. Sibener and Y. T. Lee published an experimental evidence of the internal energy dependence of the surface condensation of gaseous SF_6 and CCl_4 molecules. Capture probability, which is the fraction of incident molecules captured on the surface, was investigated experimentally verifying the surface condensation phenomena that is different between the internally excited molecules and the non-excited molecules.[(5)] The experiments were conducted using well-controlled molecular beams that are thermally excited. Here, we report the surface condensation retardation of the gaseous $CHCl_3$ molecules in a bulk fluid excited by a cw CO_2 laser.

II. Experimental

Fig. 1 shows the experimental system including the irradiation chamber(IC) and a CO_2 laser. The IC was coaxial with the laser beam and the IC inner wall temperature was controlled in the range between 130K and 180K by a liquid nitrogen heat exchanger system. A natural $CHCl_3$ (98.9% of C-12 and 1.1% of C-13) gas mixture with a carrier gas, He or N_2, flowed through the IC was captured on the cold IC wall. The CO_2 laser emission lines between 10P30(934.9 cm^{-1}) and 10P36(929.0 cm^{-1}) were used to excite the carbon atom dependent $\nu_2 + \nu_6$ binary absorption band of $CHCl_3$. Since the absorption cross-section of this binary band is about 100 times smaller than the fundamental band, the intra-cavity configuration of the CO_2 laser was used to increase the laser photon efficiency. By exciting 98.9% $^{12}CHCl_3$, it was assumed that most of chloroform molecules are at the excited states when they are flow through the IC. The condensation probability was determined by measuring the quantities of escaped molecules from the cold IC during the experiments, which are with on-line laser excitation, with off-line non-excitation, and without laser for comparison.

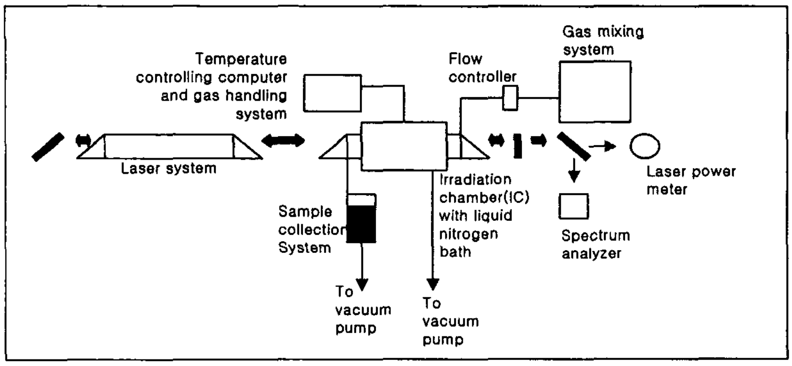

Figure 1. Comprehensive Experimental System

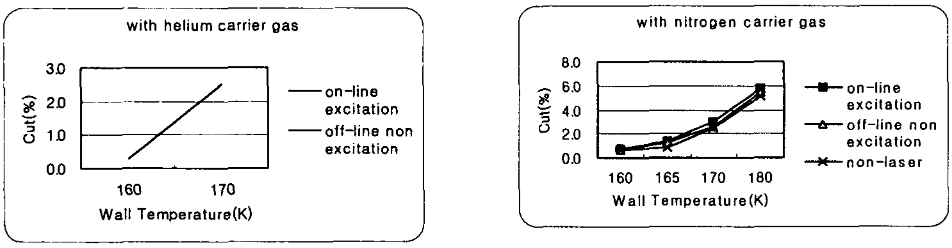

Figure 2. Condensation retardation with N_2 carrier gas at P_{IC} = 2.0 torr and C_{IC} = 2.0%

III. Result and Discussion

Experimental results are shown in Fig. 2. The cold IC escaped fractions of the vibrationally excited $CHCl_3$ molecules were increased about 14% to 20% with a N_2 carrier gas. With a He carrier gas, however, we could not observe any change in the escaped fractions under the same conditions with N_2 carrier gas experiments. This might be due to the lower excitation fraction of molecules in He carrier gas caused by higher VT rates than N_2 gas under given experimental conditions.

IV. References

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