

### §37. FIR Lasers by Two CW CO<sub>2</sub> Laser Pumping

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Cw multi-line far-infrared (FIR) lasers have been utilized as optical sources for various applications such as plasma diagnostics by a two-color interferometer and polarimeter [1], MeV gamma-ray production by inverse Compton scattering from high energy electron beam [2], and characteristic measurements of optical elements and detectors [3,4]. For these applications, the multi-line FIR lasers pumped by two cw CO<sub>2</sub> lasers have been proposed..

In order to realize the multi-line FIR laser oscillations, following conditions are required.

1. Energy levels in FIR laser molecules which relate to pumping/FIR-laser-action are independent for each laser system.
2. FIR laser cavity length is resonant simultaneously for the FIR laser lines.
3. Emitted FIR laser lines are not absorbed by inner FIR laser gasses.

Fig. 1 shows the schematic drawing of the experimental setup for FIR laser pumped by two CO<sub>2</sub> lasers. The cavity of the pump CO<sub>2</sub> laser is formed by a ZnSe output coupler (55 % in reflectivity and 20 m in radius of curvature) attached on a piezoelectric transducer (PZT) and a grating (150 lines/mm). The cavity length is 2.5 m in length for the CO<sub>2</sub> laser 1 and 4.0 m for the CO<sub>2</sub> laser 2. The pump CO<sub>2</sub> laser beams are coupled into the FIR laser cavity via two concave mirrors (MR in Fig.1) with 1.5 m in radius of curvature. The input coupler of the FIR laser cavity is a flat mirror with two off-axis holes of 3 mm in diameter. The FIR laser tube is of a 4.0 m in length, and 25 mm in inner-diameter made by Pyrex-glass. The output coupler of the FIR laser cavity is a silicon hybrid mirror with a 6 mm clear aperture at the center. The output mirror is movable by a stepping motor in order to tune the cavity length. The output window of a CVD diamond is used because of a good transmission in the FIR region. The laser gases (CH<sub>3</sub>OH and CD<sub>3</sub>OH) are slowly flowing in order to keep the purity using mass flow controllers.

Recently, the following simultaneous FIR laser oscillations with 119- $\mu$ m CH<sub>3</sub>OH laser pumped by 9P(36) CO<sub>2</sub> laser have been obtained successfully.

- (1) 62- $\mu$ m CH<sub>3</sub>OH laser pumped by 9R(18) CO<sub>2</sub> laser.
- (2) 71- $\mu$ m CH<sub>3</sub>OH pumped by 9P(34) CO<sub>2</sub> laser.
- (3) 254- $\mu$ m CD<sub>3</sub>OH laser pumped by 10R(36) CO<sub>2</sub> laser.

Fig.2 and 3 show typical examples for case (1) and (3). Now, the data base for multi-line FIR laser oscillation is under construction.

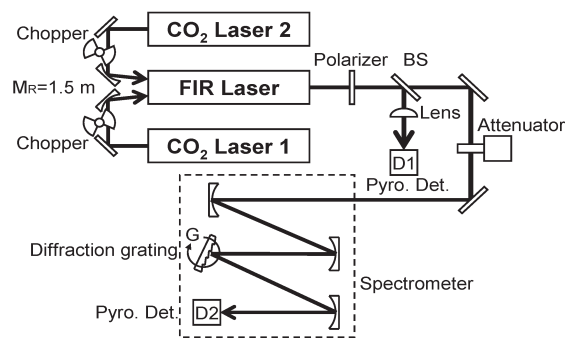


Fig. 1. Schematic drawing of FIR laser pumped by two cw CO<sub>2</sub> lasers.

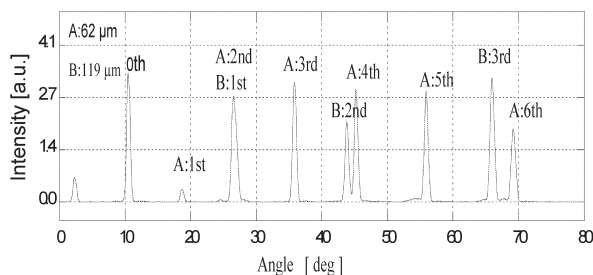


Fig. 2 Diffraction pattern by a 220- $\mu$ m grating spectrometer (Simultaneous oscillation of 62  $\mu$ m CH<sub>3</sub>OH laser pumped by 9R(18) CO<sub>2</sub> laser and 119  $\mu$ m CH<sub>3</sub>OH laser pumped by 9P(36) CO<sub>2</sub> laser)

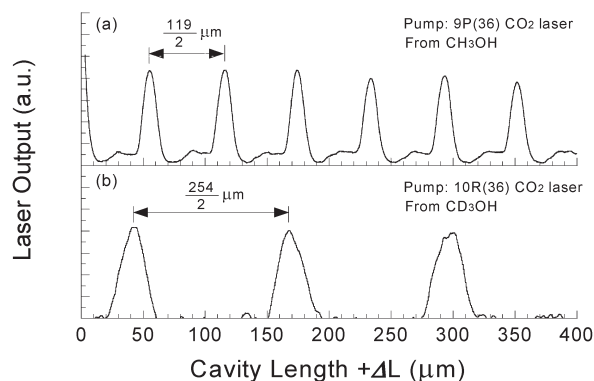


Fig.3 Detuning curves of simultaneous oscillations of (a) 119- $\mu$ m CH<sub>3</sub>OH laser pumped by 9P(36) CO<sub>2</sub> laser and (b) 254- $\mu$ m CD<sub>3</sub>OH laser pumped by 10R(36) CO<sub>2</sub> laser.

#### References

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