

New CO₂ Pumped CW Far-Infrared Laser Lines

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Abstract—A single-frequency CW CO₂ laser has been used to pump ethyl alcohol, methyl chloride, ethyl chloride, and methylene chloride, generating 8 new CW far-infrared (FIR) laser lines from 254 to 1700 μm .

Far-infrared (FIR) lasers are becoming useful radiation sources for use in spectroscopy, and many molecules exhibit lasing action when optically pumped with a CO₂ laser. We report here several new molecules and 8 new wavelengths to provide additional sources in this spectral region.

A single-frequency grating-tuned CW CO₂ laser, with a PZT for fine tuning, provided the pump source. Maximum power of 20 W in the 9.6- μm band with tuning from *P*(8) to *P*(42) and *R*(8) to *R*(36), and 40 W in the 10.6- μm band with tuning from *P*(0) to *P*(50) and *R*(0) to *R*(44) was obtained.

The FIR laser was of the waveguide design. The waveguide was a polished copper tube, of 14-mm diameter and 2.1 m long. The input and output mirrors were of copper and polished flat. FIR power was extracted through a 0.25-mm-thick fused-quartz window which covered a 2.5-mm coupling hole in the output mirror. The CO₂ pump radiation was focused through a salt window and through a 1-mm hole in the

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TABLE I

Material	Wavelength μm	CO ₂ Pump Line	Pressure μHg	Power
Ethyl Alcohol (C ₂ H ₅ OH)	396	9 P (32)	100	W
Methyl Chloride (CH ₃ Cl)	254	10 P (10)	100	M
	354	10 R (18)	100	W
	968	9 R (12)	100	W
Ethyl Chloride (C ₂ H ₅ Cl)	900	10 R (30)	100	M
	1350	10 R (30)	100	W
	1400	10 R (38)	100	W
	1720	10 R (28)	100-200	M
Methylene Chloride (CH ₂ Cl ₂)	258	10 P (26)	100	M

input mirror by a 6.4-cm focal-length germanium lens. The input mirror was moved via a micrometer from 1 to 5 mm from the end of the waveguide.

The FIR-laser radiation was detected by a quartz-window Golay cell with various attenuators between the FIR laser and the Golay cell, depending on the signal strength. The optimum pressure was in nearly all cases around 100- μm Hg. No attempt was made to determine the FIR-laser polarization relative to the CO₂-laser polarization.

The results of our measurements are summarized in Table I. The FIR power is listed as either *M* (medium) or *W* (weak) where *M* \approx 0.1 mW and *W* \approx 0.01 mW.

It is interesting to note that the ethyl alcohol line lased very well on vodka, gin, and rum, but it lased on only 1 line and rather weakly compared with methyl alcohol. It is quite obvious that there are better uses of ethyl alcohol.