9:30 am

QMB5 Tunable infrared difference frequency generation in $AgGaSe_2$ and $AgGaS_2$

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Difference frequency generation (DFG) of tunable IR radiation by mixing two high-power single-frequency cw lasers in $AgGaS_2$ or $AgGaSe_2$ provides a very attractive tunable-frequency laser source for high-resolution spectroscopy beyond 4 µm. This paper reports on the development of tunable IR laser spectrometer technology in the 4- to 18-µm spectral region that exploits recent progress in the growth technology of IR optical materials and new tunable cw pump sources. The recent commercial availability of $AgGaS_2$ and $AgGaSe_2$ crystals with excellent optical transmission characteristics of 0.5–10 µm and 0.9–18 µm, respectively, and long interaction lengths of ≥40 mm makes it possible to generate tunable cw radiation at the 100-µW level. Experiments are described that use two cw dye/Ti–sapphire lasers covering the range from 590 to 900 nm, and a 45-mm-long $AgGaS_2$ crystal cut for 90° phase matching. A schematic of the essential components of the difference frequency spectrometer is shown in Fig. 1. Wavelength, linewidths, output power, and temperature characteristics are reported. Precise computer control of wavelength scanning, wavelength calibration, and data acquisition have been implemented, based on both hardware and software techniques developed for color-center and diode laser spectrometers in our laboratory. Software is also available with the Autoscan version of Coherent Model 899-29 dye/Ti–sapphire ring laser.)

Initial experiments were performed with Rh6G dye laser covering 580–625 nm, a DCM dye laser covering 630–670 nm, and a Ti–sapphire laser operating from 700–770 nm, each capable of ~500 mW when operated in single frequency and pumped by 6W of argon ion laser power. Ultranarrow linewidths ($<10^{-4}$ cm^{-1} or 1 MHz) tunable IR radiation occurs in two IR spectral regions: 1100–1450 cm^{-1} (7–9 µm) and 1550–1900 cm^{-1} (5–6 µm).

The performance of the DFG laser spectrometer has been evaluated using the NH_3 spectrum at 1195 cm^{-1} and, more recently, as depicted in Fig. 2, the Q branch of the N_2O spectrum at 1880 cm^{-1} in a multipass absorption cell.

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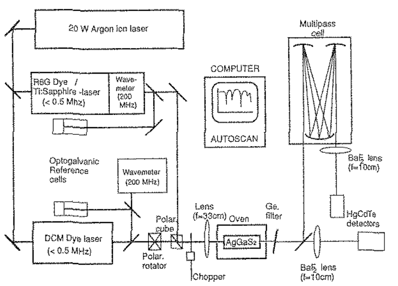
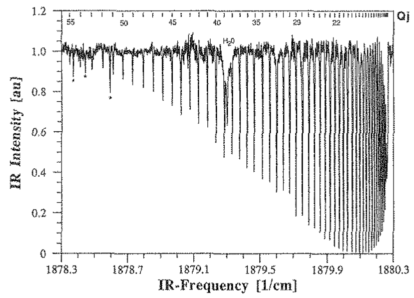


QMB5 Fig. 1. Schematic diagram of the cw infrared difference frequency generation laser spectrometer.



QMB5 Fig. 2. Survey absorption spectrum of the Q 1110 branch of N_2O at 1880 cm^{-1}. The N_2O pressure is 300 mTorr and the path length about 30 m. Data points are taken every 20 MHz.