BLUE DIODE LASERS IN SPECTROSCOPIC APPLICATIONS

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Diode lasers have provided many new possibilities for high-resolution laser spectroscopy (see, e.g., Ref. [1]). For a long time diode laser action was limited to the infrared, near infrared and red spectral regions. With the introduction of violet and blue continuous-wave diode lasers [2] through the work of Nakamura et al. at the Nichia Corporation, the spectroscopic applicability of diode lasers was much augmented. By special agreement with the manufacturer our group was able to perform very early experiments with two units, one operating close to 404 nm and another one close to 397 nm. In this contribution we report on our experiences with these new spectroscopic sources [3-6].

The output power of the blue/violet lasers used is about 5 mW. The lasers need an external tunable cavity to operate in a single longitudinal cavity mode, and the power is then reduced to the order of 1 mW. Our first experiments [3] concerned the second resonance lines of potassium at 404.5 and 404.8 nm. Absorption, fluorescence and opto-galvanic spectroscopy were demonstrated. Ultra-sensitive atomic detection employing two-tone frequency modulation spectroscopy was demonstrated on potassium (Fig. 1.) and on the lead 405.8 nm line originating from a weakly populated metastable level [4].

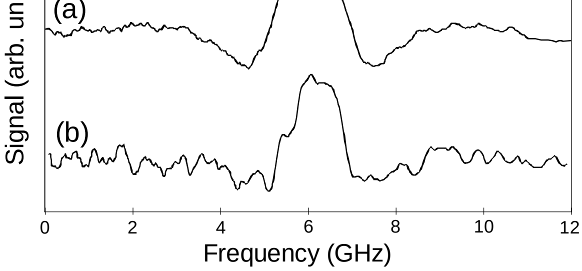

Figure 1. Sensitive detection of potassium in a low pressure cell at 404 nm using modulation techniques for small absorption measurements. Wavelength-modulation signal (a) and two-tone frequency modulation signal (b).

We also demonstrated sum-frequency generation to the 253.7 nm mercury line [5]. Here the light from the 404 nm and a 688 nm diode laser was mixed in a BBO crystal. In low pressure samples the well-resolved spectral structures of mercury isotopes could be seen. Experimental recordings are shown in Fig. 2. This type of mixing to the ultra-violet region is quite useful in generating new frequencies as is the difference-frequency generation to the mid-infrared region (see, e.g., [7]).

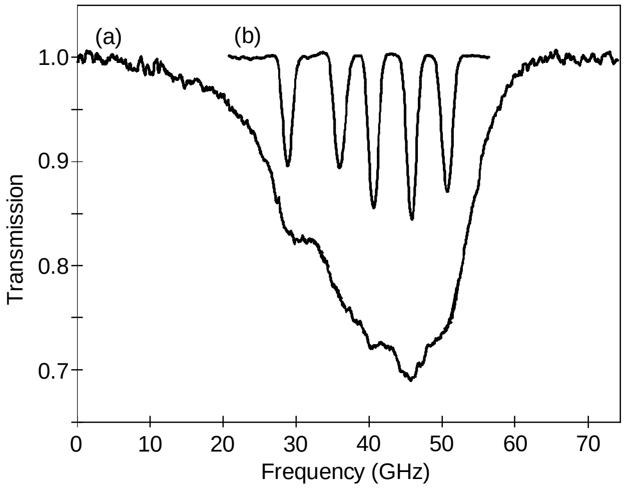

Figure 2. Mercury monitoring at 254 nm using sum-frequency generation from a blue and a red diode laser. Absorption signal at atmospheric pressure (a) and at low pressure (b).

A further use of violet diode lasers is as excitation sources for laser-induced fluorescence. We have built a very compact fibre-optic fluorosensor combining a violet diode laser with an integrated spectrometer [6]. The unit has been used, e.g. for early cancer detection.

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[3] U. Gustafsson, J. Alnis and S. Svanberg, *American J. Phys.* tentatively Vol. 68, April 2000.

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[7] U. Gustafsson, J. Sandsten and S. Svanberg, *Appl. Phys. B.*, to appear.