GaN BLUE DIODE LASERS IN SPECTROSCOPIC APPLICATIONS

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With the introduction of GaN violet and blue continuous-wave diode lasers [1] 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 experience with these new spectroscopic sources [2-4]. The spectroscopic applications of the blue diode lasers have also been investigated in [5,6].

The output power of the blue/violet lasers used is about 5 mW, although at present 30 mW diode lasers are also available. The lasers need an external tunable cavity to operate in a single longitudinal cavity mode, and the power is then reduced to about 1 mW. Our first experiments [2] 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 and on the lead 405.8 nm line originating from a weakly populated metastable level [3]. $^{40}Ca^{+}$ excitation in an ion storage ring using a Littrow-type external-cavity stabilised blue diode laser was performed in collaboration with the Manne Siegbahn Institute in Stockholm for lifetime determination of metastable states.

Initial investigations using a simple photometer setup and frequency modulation spectroscopy for high sensitivity detection of nitrogen dioxide NO_2 in air were performed.

We also demonstrated sum-frequency generation to the 253.7 nm mercury line [4]. 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. 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]).

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 [8]. The unit has been used, e.g. for early cancer detection.

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