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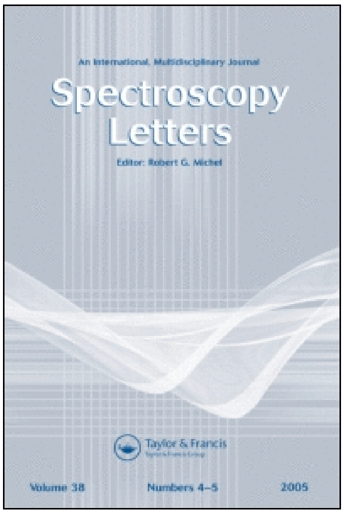

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Dye Laser for Absorption Trace Analysis of Sodium

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DYE LASER FOR ABSORPTION TRACE ANALYSIS OF SODIUM

KEY WORDS: Absorption, Trace analysis, Dye laser

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INTRODUCTION

The advent of organic dye lasers made possible many experiments in physics, chemistry and biology. Most of these applications are based on the possibility to tune dye laser emission almost at any wavelength between 3400 Å and 12000 Å.This quality combined with high light power made feasible multiphotone absorption, selective absorption and fluorescence experiments. Recently a group of authors published the papers: "Enhancement of absorption spectra by dye laser quenching I and II"[1,2] which start a new field of applications of dye lasers. Namely if a weak absorber is placed inside the broad band laser cavity the absorption is enhanced and this results in the same absorption bands or lines observable in the spectrally resolved laser output. This effect can be used for detection of the traces of elements as a complementary method to the classical absorption spectroscopy but with much higher sensitivity. Same method could be also very useful for detection of transient species with a very short lifetimes.

The aim of this work is to demonstrate the application of dye laser absorption technique for the detection of the traces of sodium in the flame.

EXPERIMENTAL APPARATUS

The experimental arrangement is shown shematically in Fig. 1. It consisted of a flashlamp pumped rhodamine 6G dye laser with the flame inside the cavity. The light from the laser is shone through neutral density filter into the slit (slitwidth 17 μ) of the spectrograph Zeiss PGS-2 with an inverse linear dispersion in the first order of 7.35 Å/mm. The spectra were recorder on Ilford R-40 spectrographic plates.

Dye laser consisted of a home-made xenon flashlamp with organic dye in the central part, Fig.1, surrounded with water cooled jacket and with xenon filling in the outer part of the lamp. The whole flashlamp is made of Pyrex glass with tungsten

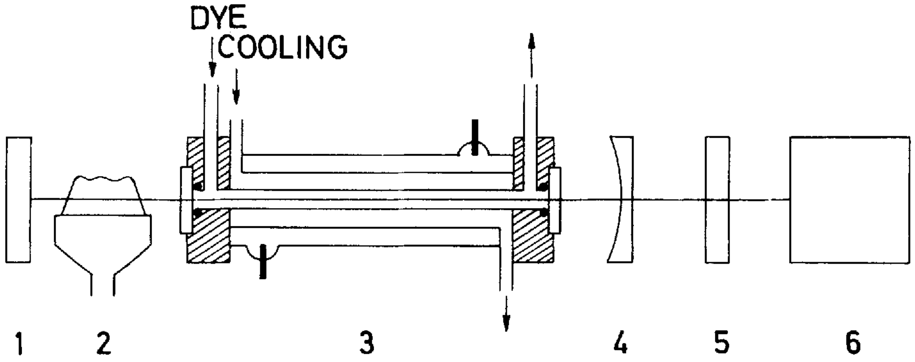

FIG. 1

Shematic diagram of apparatus: 1- 99.5% reflectance mirror, 2- burner with flame, 3- dye laser flashlamp, 4- 98.5% reflectance mirror, 5- neutral density filter, 6- spectrograph.

electrodes. The dye solution and water are circulated through the flashlamp by means of a peristaltic miniflow pump and the solution was maintained at approximately room temperature. The experiments were carried out with air equilibrated methanolic solution of rhodamine 6G (BDH absorption indicator) which was not further purified. The concentration of the dye solution (50 mg/ℓ of rhodamine 6G in methyl alkohol) was adjusted in order to obtain dye laser broad band (about 80 Å wide) emission in the region of interest. Hemispherical laser resonator consisted of one flat dielectric mirror coated for 99.5% and one curved mirror (radius 100 cm) with 98% reflectivity at 5900 Å. These mirrors were spaced approximately 40 cm appart.

Flashlamp was mounted on the capacitor in order to minimize inductance of the electric circuit. The discharge was driven by low inductance 2.5 μF capacitor charged from 4.5 to 5.8 kV. The discharge was initiated by high voltage pulse applied to external coiled wire electrode. In Fig.2 is given the caracteristic flashlamp light and the laser pulse.

The air-natural gas flame (burner - 10.6 cm long and 1 cm wide) is used together with Hilger-Watts commercial atomiser (attachment 1100). Laser light pasts trough the central part of the flame (8 mm from the burner) along the longer side of the burner. Sodium is introduced in the flame in the form of NaCl water solution. All the precautions were taken to avoid contamination of the analysed solutions with sodium and therefore during the experimental plastic instead of glass vessels were used.

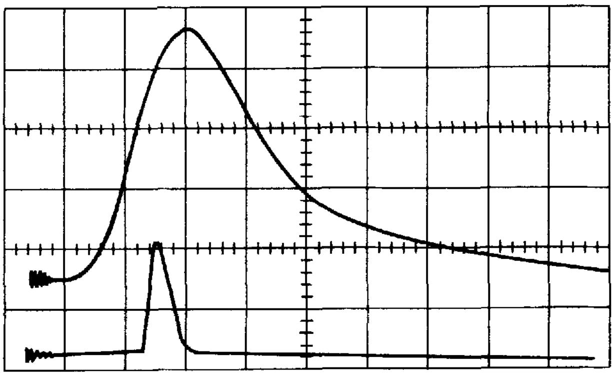

FIG. 2

Characteristic flashlamp pulse (upper trace) and laser emission of rhodamine 6G in methyl alcohol. Time base 2 μs per large division.

RESULTS AND CONCLUSIONS

The presence of an absorber within the laser savity is detected in form of sodium doublet 589.00 nm and 589.59 nm absorption lines in the broad-band laser dye emission. However both sodium lines are easily detected in the flame alone and therefore it was neccessary to determine sodium in the solutions in the presence of the constant background. It should be emphasised that sodium could not be detected in the used air-natural gas flame by means of commercial instruments. Still with the dye laser technique it was possible to determine the concentrations as low as 2×10^{-10}g/ℓ. This exceeds the sensitivity of all commercial instruments at least two orders of magnitude.

Finally it should be taken in account that the photographs of the laser spectrum were taken in an interval of time of 1.4 μs (the length of the single dye laser pulse Fig.2). This time interval can be easily decreased to few tens of nanoseconds if laser pumped dye laser is used. This illustrates the applicability of this technique for detection of short-life species.

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