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A method to optimalize the tunability range of dye laser

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In tunable dye lasers, usually broad-band dielectric mirrors are used for outcoupling the laser beam [1, 2]. For dyes with low gain the transmittance of the mirror is about 50 %, and can be as high as 90 % for high gain dyes. The optimum outcoupling has been theoretically studied in [3]. The problem arises from the fact that near the limits of the tunability range the gain of the "high gain" dyes drops and the laser becomes overdamped; consequently the range of tunability decreases. The usage of sets of dielectric mirrors is cumbersome and provides only discrete values of transmittance.

A method proposed in this paper enables a continuous variation of the outcoupling rate of the laser light allowing to achieve an optimum for any wavelength and the corresponding gain.

According to this method a variable beamsplitter attenuator (VBS-attenuator), is inserted into the laser cavity, that consists of a tuning grating and a non-transmitting plane mirror with aluminium coating. The beam splitter attenuator is a variable reflectivity aluminium mirror with a flat spectral response and the relative ratio between the reflected and transmitted intensity can be adjusted continuously. Since it is set at 45 degrees of the optical axis of the cavity, the outcoupled beam reflected from the surface of the beam splitter leaves the cavity perpendicularly to the optical axis (see fig. 1). Near the limits of the tunability range smaller values of damping

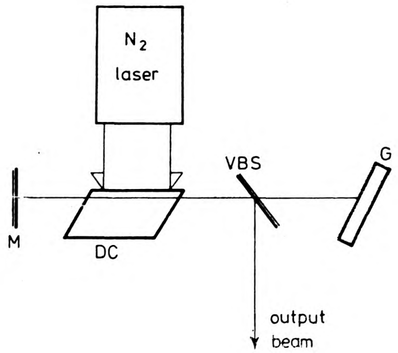

Fig. 1. Dye laser with the variable beam splitter outcoupling:
M – aluminium mirror, *D* – day cuvette, *G* – diffraction grating 2000 lines/mm, VBS – variable beam splitter

are set and thus a wider tunability range may be achieved than that given by the value of damping providing the optimum performance at the wavelength corresponding to the maximum gain of the dye used.

The simple experimental setup of the dye laser with the beam splitter outcoupling is shown in fig. 1. A 300 kW pulsed N_2 laser was used to pump the dye laser that operated with Rhodamine B. The energy of the output beam was monitored by a Si photoelement taking account of its spectral response. Pulse energy as a function of operation wavelength was measured for different settings of the VBS, i.e. for different transmittance reflection ratios.

The tuning curves of the Rhodamine B laser are shown in fig. 2. Dotted line shows the performance of the laser with constant beam splitter setting that optimizes the output at $\lambda = 615$ nm. Solid line shows the wavelength of the intensity in case when

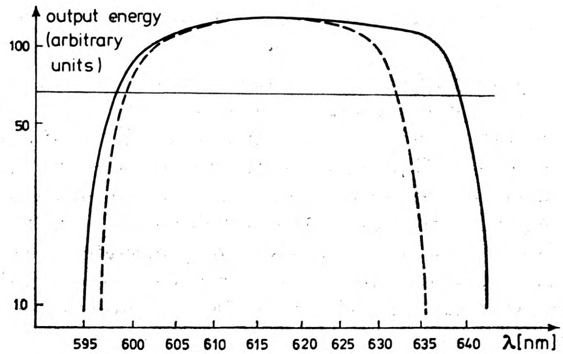

Fig. 2. Wavelength dependence of the output energy of the Rhodamine *B* dye laser with fixed VBS setting (dotted line), and VBS setting optimalized for each wavelength (solid line)

the VBS was set to the optimum value at each wavelength.

It is clear from the figure that about 20% wider useful tunability range (over which the intensity is above 50% of its maximum value — horizontal line in fig. 2) can be achieved using this method.

Further advantage of the arrangement is that when using different dyes with different gains the optimal outcoupling can always be determined in this very simple way for any wavelength of operation.

References

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