L.11: Copper vapor laser pumped dye laser with a ternary-mixture of dyes

The dye laser provides tunable operation from near UV to near IR by using different laser dyes as gain medium. It is always desired to use that laser dye, which provides emission at the desired wavelength range and absorbs all wavelengths available in the pump beam for best utilization of the pump energy. However, sometimes a single dye does not have the required absorption and emission characteristics then a mixture of dyes is used as the gain medium in the dye laser. The output of a copper vapor laser (CVL) consists of two wavelengths, 510.6 nm (green) and 578.2 nm (yellow) and a significant amount of pump power is wasted in CVL pumped dye lasers by the dyes, which are pumped by either 578.2 nm or 510.6 nm. Laser radiation in the region of at 633 nm is required for many applications, like coherent optical image amplification, photodynamic therapy, etc. A ternary-mixture of laser dyes, composed of Rhodamine 640, Rhodamine 6G and DCM was prepared in ethanol and its spectral characteristics as a function of concentrations of dyes were studied in Laser Systems Engineering Section of RRCAT, Indore to obtain peak emission at 633 nm by absorbing both wavelengths, viz. 510.6 and 578.2 nm of CVL.

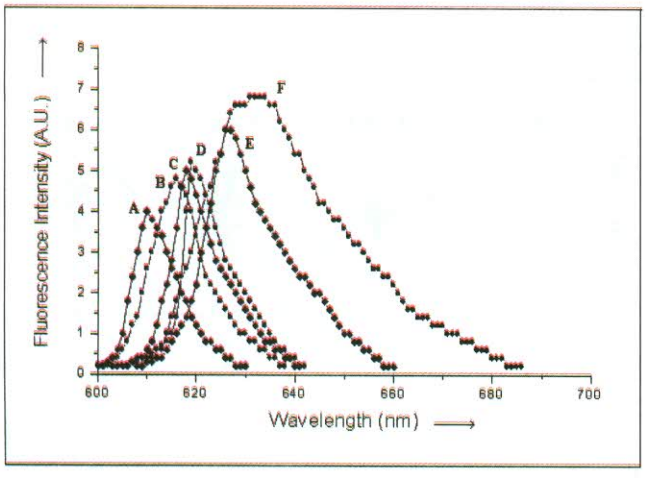

Fig. L.11.1: Change in width and peak of fluorescence of the ternary-mixture with change in concentration of constituent dyes. Fluorescence spectra of dye solutions in ethanol: (A) Rhodamine 640 (0.16 mM), (B) Rhodamine 640 (0.30 mM), (C) Rhodamine 640 (0.54 mM), (D) Rhodamine 640 (0.90 mM) + Rhodamine 6G (0.30 mM), (E) Rhodamine 640 (0.90 mM) + Rhodamine 6G (0.30 mM) + DCM (0.40 mM), and (F) Rhodamine 640 (0.90 mM) + Rhodamine 6G (0.30 mM) + DCM (0.90 mM).

The concentrations of the dyes in the mixture, excited by both wavelengths of CVL, were optimized to obtain a fluorescence spectrum with desired peak emission. In the experimental set-up, the dye solution was circulated through a homemade flowing dye-cell (DC) connected to a homemade circulation system. Excited by both wavelengths of CVL, the fluorescence spectra of the dye solutions of different concentrations of individual dyes are shown in Fig. L.11.1.

The mechanism of excitation energy transfer among constituent dyes of the ternary mixture was operative and the resultant fluorescence range of the ternary-mixture of laser dyes Rhodamine 640 (0.90 mM), Rhodamine 6G (0.30 mM) and DCM (0.90 mM) in ethanol was 612-679 nm with a relatively broad peak at 631-634 nm. Thus the ternary-mixture, excited by both wavelengths of CVL, is a suitable gain medium to provide peak emission at 633 nm. This ternary-mixture of dyes was used as gain medium in a narrowband tunable dye laser oscillator, transversely pumped by both wavelengths of CVL; and a spectral tuning range of 620-665 nm with an almost a flat peak at 630-634 nm was obtained, Fig. L.11.2.

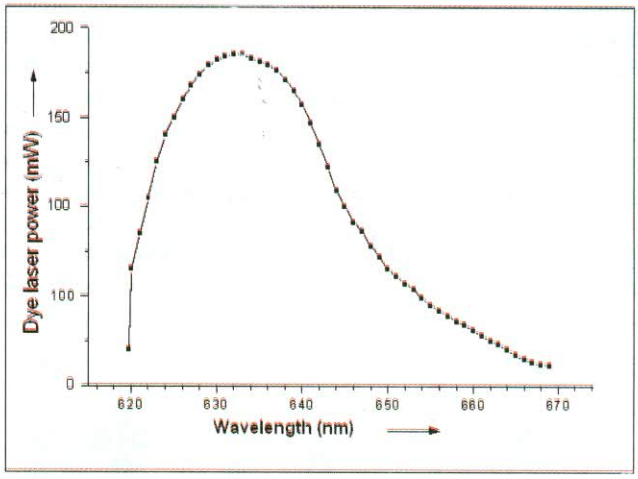

Fig. L.11.2: Spectral tuning range of the ternary-mixture of dyes, composed of Rhodamine 640 (0.9 mM), Rhodamine 6G (0.3 mM) and DCM (0.9 mM) in ethanol, in a dye laser pumped by both wavelengths of CVL.

For more details of the present work, please refer to R. Khare et al., Opt. Commun. 313, 299 (2014).

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