EFFICIENT BROADBAND TUNING OF A BLUE-GREEN *XeF(C→A)* EXCIMER LASER

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Summary

The electron-beam excited $XeF(C \rightarrow A)$ laser is broadly tunable by means of injection-control and has the potential for a relatively high efficiency as well as narrow band width operation [1]. However, *efficient* broadband tuning is impaired by absorption from transient species and decreasing gain in the wings of the $XeF(C \rightarrow A)$ gain profile. Recent experiments have shown that the transient absorbers appear to be saturable through the use of an intense injection laser pulse [2]. Using a long pulse coaxial flash lamp pumped dye laser as an injection source, continuous wavelength tuning has been achieved between 470 and 500 nm with a spectral width of 0.6 nm. Wavelength tunability to both shorter and longer wavelengths will also be discussed.

The experimental setup used in this investigation is shown in Fig. 1. A kinetically tailored laser gas mixture comprised of NF_3 (8 torr), F_2 (1 torr), xenon (8 torr), krypton (300 torr), and argon (6.1 atm) was pumped by a short pulse (10 ns), high current density (250 A/cm^2) electron-beam, having an energy of 1 MeV [1,3]. An electron-beam energy deposition of 110 J/l was achieved by means of a backscattering reflector inside the laser cell. The optical cavity was a positive-branch confocal unstable resonator with a magnification $M = 1.15$ and a cavity length $L = 12.5$ cm. A flash lamp pumped dye laser output (250 ns pulse duration) was injected into the cavity through a 1.5 mm dia. hole in the center of the concave reflector. The amplified output was examined as a function of injected wavelength and power. The role of the cavity in this configuration was to serve as a beam expanding telescope for a regenerative amplifier.

In order to investigate the tuning characteristics of the laser, specific wavelengths were chosen to correspond to either gain maxima or absorption valleys in the free-running $XeF(C \rightarrow A)$ laser spectrum as shown in Fig. 2. The overall shape of this spectrum is determined not only by the coating bandwidth of the cavity mirrors, but also by wideband absorption, primarily due to photoionization of excited Xe atoms, and discrete narrowband absorption, due to phototransitions of Xe, Ar, and Kr excited atoms [4]. Presented in Fig. 3 are the measured energy extraction characteristics as a function of wavelength corresponding to an injection power density value of 360 kW/cm^2. The figure depicts the superposition of spectra of eight separate injection-controlled laser shots, and shows that with a relatively high power injection the valleys become very much less pronounced, and the wavelength tuning curve becomes relatively smooth. In fact, the output energy varied only by a factor of two over a 30 nm region. This decrease in induced transient absorption appears to result from bleaching by the intense injection photon flux. This is also confirmed by gain measurement as a function of probe laser power density. For the conditions depicted in Fig. 3, output energy density values between 0.7 and 1.3 J/l are obtained over a 30 nm wavelength range corresponding to an intrinsic efficiency of $\sim 1\%$.

In conclusion, the $XeF(C \rightarrow A)$ excimer laser is efficient and continuously tunable over a wide range of the blue-green wavelengths.

References

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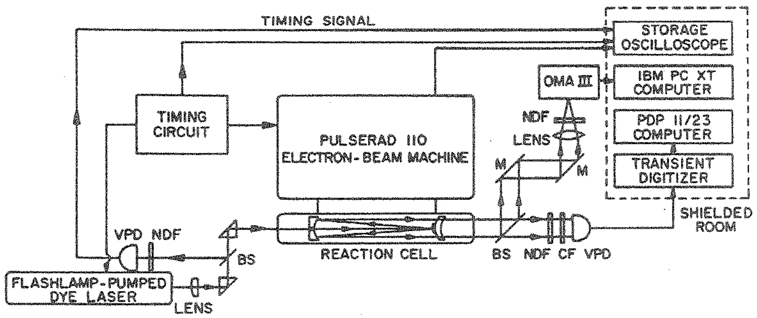

Figure 1. Schematic illustration of the experimental setup.

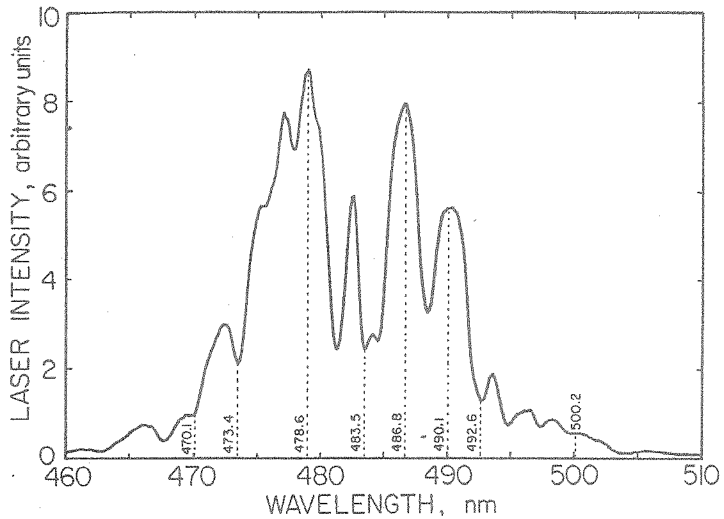

Figure 2. Free-running $XeF(C \to A)$ laser spectrum. Specific wavelengths for the tuning experiments are indicated.

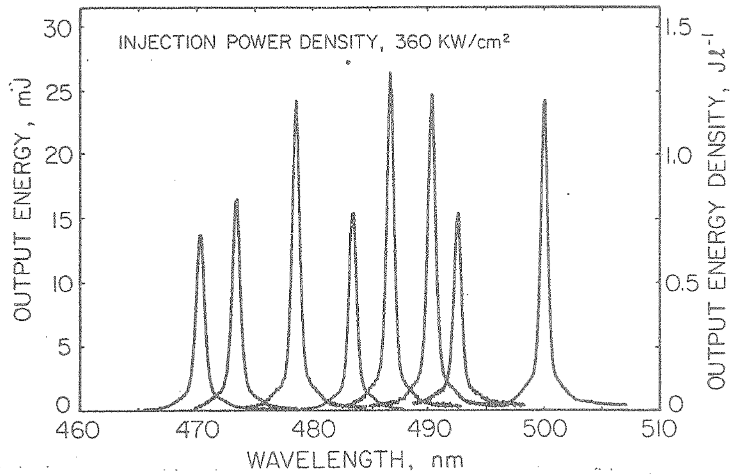

Figure 3. Amplified injection-controlled $XeF(C \to A)$ laser output for various separate injection wavelengths.