CTHF2 Wavelength-agile XeF(*C* → *A*) excimer laser

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The XeF(*C* → *A*) excimer laser is an efficient scalable source of radiation continuously tunable over an ~50-nm band centered at 485 nm. Using a high current density (150-A/cm^2), short pulse (10-ns FWHM) electron-beam excitation source, and kinetically tailored five-component gas mixture,[1] laser energy, energy density, and intrinsic efficiency values of >0.8 J, 1.7 J/liter, and 1.3%, respectively, have been demonstrated on a single shot basis.[2,3] We report the first demonstration of wavelength-agile tuning of the XeF(*C* → *A*) laser operating in the repetitively pulsed mode.

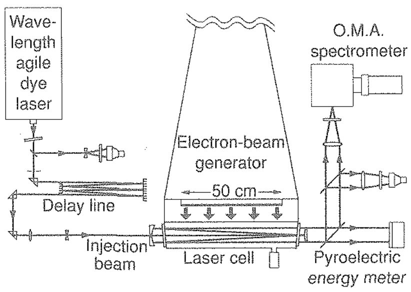
The most effective way to tune the wavelength of the XeF(*C* → *A*) excimer laser is by injection control. Laser wavelength control was provided by injecting a dye laser pulse (30 ns FWHM) of a few millijoules through a small hole in the end reflector of a positive branch confocal unstable resonator, as illustrated in Fig. 1. The unstable cavity had magnification values in the 1.3–2.0 range with the optics mounted either internal or external to the laser gas cell. The 1-Hz prf electron-beam system deposited 60 J in a 6.5-bar gas mixture consisting of 12 ± 2-Torr NF_3, 1 ± 0.5-Torr F_2, 12 ± 2-Torr Xe, 750 ± 150-Torr Kr and Ar. The active length, diameter, and volume were 50 cm, 3.5 cm, and 0.48 liter, respectively.

Wavelength agility was provided by way of the injected dye laser pulse. A commercial excimer pumped dye laser system was used for this purpose with the dye laser oscillator modified to permit high speed and wavelength tuning.[4] As illustrated in Fig. 2, the dye laser oscillator consists of a tranversely pumped cuvette, polarizing beam splitter which serves as a low reflectance output coupler, grazing incidence grating, and galvanometer driven end mirror to provide tuning. High speed wavelength agility is made possible through incorporation of a telescope permitting use of a small (1-cm) tuning mirror. With this arrangement, tuning speeds up to 250 Hz are possible, although the present system was limited to the 70-Hz prf of the 308-nm excimer pump. Both dye laser pulse energy and wavelength are measured for each pulse using a pyroelectric detector and Fizeau wavemeter incorporated into the system.

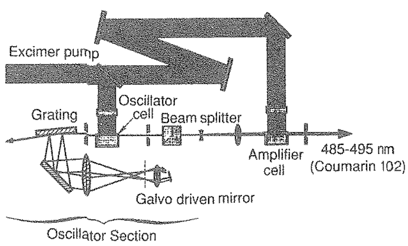
The dye laser injection control and electron-beam systems are completely integrated and controlled entirely by computer. Wavelength-agile pulse-to-pulse tuning is achieved by entering a list of preselected wavelengths in any sequence into the injection laser control computer. The synchronous operation of the injection control and electron-beam systems permits scanning through the selected wavelength sequence for as many iterations as desired. Figure 3 shows the measured XeF(*C* → *A*) laser energy for wavelengths selected to correspond to maximum gain values in the *C* → *A* laser spectrum. For the purpose of this demonstration, the electron-beam prf was 0.1 Hz, and the wavelengths were scanned in an arbitrary sequence over the 472–494-nm range. The spectral width of the laser output was ~0.015 nm, the same as that of the injection laser. Numerous other wavelength sequences have been demonstrated including those of special significance such as the blue-green wavelengths of the active Rb atomic resonance filter.

These results demonstrate all the essential elements of a scaled repetitively pulsed wavelength-agile XeF(*C* → *A*) laser system, thus confirming the potential of this unique tunable laser for a variety of uses requiring high energy/power.

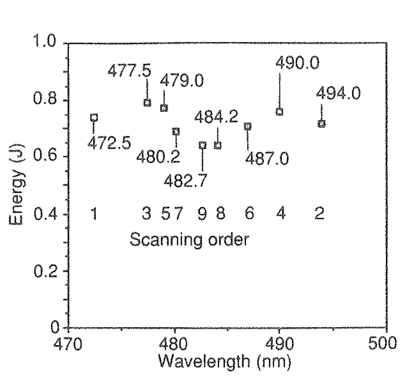
1. W. L. Nighan, R. Sauerbrey, Y. Zhu, F. R. Tittel, and W. L. Wilson, "Kinetically Tailored Properties of an Electron-Beam Excited XeF(*C* → *A*) and XeF(*B* → *X*) Laser Medium Using an Ar–Kr Buffer Mixture," IEEE J. Quantum Electron. **QE-23**, 253–261 (1987).
2. G. J. Hirst, C. B. Dane, W. L. Wilson, R. Sauerbrey, F. R. Tittel, and W. L. Nighan, "Scaling of an Injection Controlled XeF(*C* → *A*) Laser Pumped by a Repetitively Pulsed, High Current Density Electron Beam," Appl. Phys. Lett. **54**, 1851–1853 (1989).
3. C. B. Dane *et al.*, "Scaling Characteristics of the XeF(*C* → *A*) Excimer Laser," IEEE J. Quantum Electron. (in press)
4. R. A. Rubino, W. L. Nighan, W. H. Glenn, A. J. Cantor, and M. J. Roman, "Wavelength Agile Dye Laser," in *Conference Digest, 1989 LEOS Annual Meeting* (IEEE/LEOS, Piscataway, NJ, 1989), paper UV2.3.



CTHF2 Fig. 1. Schematic of the overall experimental arrangement showing the electron-beam generator and laser cell, wavelength-agile injection laser, and system diagnostics.



CTHF2 Fig. 2. Schematic of the wavelength-agile dye laser injection system showing the essential elements of the oscillator.



CTHF2 Fig. 3. XeF($C \rightarrow A$) laser output energy for injection wavelengths corresponding to the peaks in the XeF($C \rightarrow A$) gain profile. Each point corresponds to a separate laser shot with the wavelengths scanned in the order indicated. The prf was 0.1 Hz, the laser spectral width was ~0.01 nm, and the injected energy was 2 mJ.