## TUO1 XeF(*C*—*A*) amplifier: an efficient tunable visible laser

R. A. SAUERBREY, W. L. WILSON, JR., FRANK K. TITTEL, Rice U., Electrical & Computer Engineering Dept., Houston, TX 77251-1892; W. L. NIGHAN, United Technologies Research Center, East Hartford, CT 06108.

It was demonstrated in the past that the XeF(*C*—*A*) laser is an efficient potentially broadband tunable visible laser. Recently, narrowband (0.001-nm) laser output from an injection-controlled XeF(*C*—*A*) laser was reported.[1] However, broadband tuning was impaired by absorption from transient atomic species and a decreasing gain in the wings of the XeF(*C*—*A*) tuning range. These shortcomings can be overcome when a high-intensity quasi-cw injection source is employed. Experiments using such a source are reported that characterize the XeF(*C*—*A*) laser over a wide parameter range.

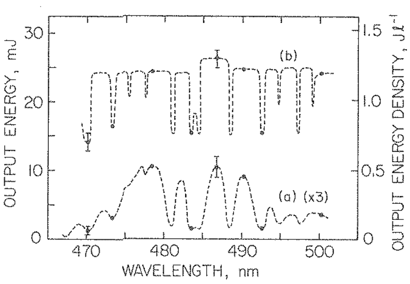
Gas mixtures comprised of argon (6.5 atm), krypton (300 Torr), xenon (8 Torr), $NF_3$ (8 Torr), and $F_2$ (1 Torr) were pumped by an electron beam (1 MeV, 250 A $cm^{-2}$, 10 ns). The excited medium was placed inside a confocal unstable resonator of varying magnification. The output of a flashlamp-pumped dye laser (250-ns pulse duration) was injected into the cavity through a hole in the convex full reflector, and the amplified dye laser signal was recorded as a function of injected wavelength, power, and pumping density.

A typical result for the wavelength dependence of the amplifier output is shown in Fig. 1. At low injected energies, i.e., in the unsaturated region of the amplifier, the output energy varies by as much as a factor of 10 depending on whether the injection laser is tuned to an absorption valley or a gain peak. When the amplifier saturates at high-injected energies, the laser output increases. More importantly, the laser output varies by a factor of $<2$ when tuned from an absorption valley to a gain peak, and energy extraction values between 0.7 and 1.3 J/liter are obtained over a 30-nm wavelength range corresponding to an intrinsic efficiency of $\sim$1%.

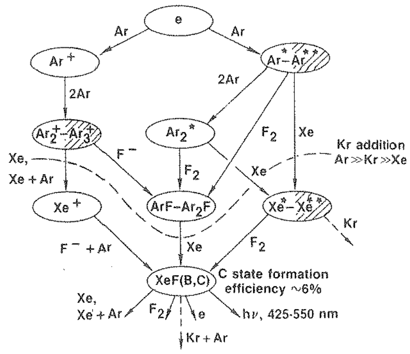
The complex kinetic processes in an electron-beam-pumped gas mixture containing five different components are shown in Fig. 2. The electron-beam energy is predominantly deposited in argon. In krypton-containing mixtures, the energy from ionized and excited argon states is rapidly transferred to the analogous krypton states and then flows to excited atomic and molecular xenon states and to $Kr_2F$.[2,3] Three-body recombinations and displacement reactions then lead to the upper laser state XeF(*C*), which is produced with a formation efficiency of $\gtrsim$6%. In particular, the combination of argon and krypton results in medium properties that are not attainable using either buffer gas alone, including reduced absorption in the blue-green region, increased absorption at the 350-nm *B*—*X* transition wavelength, and enhanced XeF(*C*) formation. The kinetic model agrees well with a wide variety of experimental results and is capable of predicting some of the fine details in the experiments.

Summarizing: The XeF(*C*—*A*) laser amplifier has now been sufficiently characterized to consider the scaling of this laser system to higher absolute performance levels. **(Invited paper, 25 min)**

1. F. K. Tittel, G. Marowsky, W. L. Nighan, Y. Zhu, R. A. Sauerbrey, and W. L. Wilson, Jr., "Injection-Controlled Tuning of an Electron Beam Excited XeF(C → A) Laser," IEEE J. Quantum Electron. **QE-22,** 2168 (1986).
2. W. L. Nighan, R. Sauerbrey, Y. Zhu, F. K. Tittel, and W. L. Wilson, Jr., "Kinetically-Tailored Properties of Electron Beam Excited XeF(C → A) and XeF(B → X) Laser Media using an Ar-Kr Buffer Mixture," IEEE J. Quantum Electron. **QE-23,** 253 (1987).
3. W. L. Nighan, F. K. Tittel, W. L. Wilson, Jr., N. Nishida, Y. Zhu, F. Emmert, and R. Sauerbrey, "Synthesis of Rare Gas-halide Mixtures Resulting in Efficient XeF(C → A) Laser Oscillation," Appl. Phys. Lett. **45,** 947 (1984).




TUO1 Fig. 1. XeF(*C*—*A*) amplifier output as a function of wavelength for (a) the unsaturated amplifier and (b) the saturated regime.




TUO1 Fig. 2. XeF(*B*,*C*) formation and loss processes.