FORTHCOMING PAPERS

Laser Enrichment of Carbon-14

L. Mannik, S. K. Brown (Canada)

An experimental study has been performed of the carbon-14 enrichment achievable in the ultraviolet laser dissociation of mixtures of $^{14}CH_2O$ and $^{12}CH_2O$. The ^{14}C:^{12}C enrichment factor in the CO product has been measured at 352.2 nm as a function of laser linewidth, formaldehyde temperature and pressure, and degree of carbon-14 depletion. The enrichment decreases with an increase in each of these parameters; the highest enrichment, 1190, was measured at 0.02 cm^{-1}, 303 K, 1 Torr and a ^{14}C depletion of 10%. The results are assessed in terms of their application of radiocarbon dating, in particular for groundwater dating required for nuclear waste disposal, and to the enrichment of ^{14}C operating wastes extracted from nuclear reactors to a level suitable for commercial sale.

Inversion of Atomic Resonance Transitions by Electron Collisional Dissociation

M. Neiger, W. Kaesler, H.-P. Popp (F. R. Germany)

Population inversion of several resonance transitions in the rare-earth atom thulium has been achieved by electron collisional dissociation of TmI_3 molecules in a fast electric discharge configuration. The inversion manifests itself by a strong spiking behavior during the initial current rise and lasts for several nanoseconds. Results of a model calculation of this inversion process for resonance lines support our experimental findings.

Modeling of High-Pressure 12-μm NH_3 Lasers

H. D. Morrison, B. K. Garside, J. Reid (Canada)

Experimental measurements of small-signal gain in an optically-pumped NH_3 amplifier are carried out at pressures ranging from 40 Torr to 760 Torr, and the results are used to validate a rate-equation model describing the amplifier dynamics. The gain measurements show that dilute mixtures of $<0.5\%$ NH_3 in N_2 are required to minimize the problems of gas heating due to pump absorption. The model is used to extrapolate the results to gas pressures of several atmospheres, and to demonstrate the potential for high-pressure operation of optically-pumped NH_3 lasers. For a pump intensity of 100 MW/cm^2, calculations indicate that operation of an NH_3-N_2 laser is feasible up to a pressure of 10 atm, which would provide a maximum continuous tuning range of 4 cm^{-1}. High-resolution spectroscopy reveals that gain on a few NH_3 transitions is eliminated at high pressures due to the presence of overlapping absorptions in other NH_3 bands.

Scaling and Performance of CO_2 Lasers at Supra-Atmospheric Pressure

A. L. S. Smith, J. Mellis (U.K.)

The performance of a compact uv photo-preionized TE laser is studied in the pressure range 1-5 bar. As the pressure is increased, the laser pulse shape is little altered, but both the peak power and the total output pulse energy increase significantly with pressure, even for constant input electrical energy. For various gas mixtures and excitation source capacitors the measurements suggest approximate output energy scaling with the product of the source charge per unit electrode area $[C \cdot m^{-2}]$ and the molecular partial pressure $[CO_2 + N_2 + CO]$. This is explained in terms of the pressure-dependent discharge impedance. An input-energy-related discharge instability limits the optimum laser pressure to 1.5-2.5 bar, and we show that, at constant input energy, the instability boundary depends on the molecular partial pressure alone. The preionization photo-electron yield varies negligibly with pressure, but the discharge tolerance to added oxygen decreases as p^{-3} to p^{-4}, dependent on gas mixture. Nevertheless sealed operation for $> 10^5$ shots has been obtained with a 5% CO_2:5% CO:3% N_2:2% H_2:85% He gas mixture at a total pressure of 5 bar.

Injection Locking of ArF Excimer Lasers

A. C. Cefalas, T. A. King (U.K.)

Injection-locking characteristics of an ArF excimer oscillator-amplifier laser are described including the use of stable-unstable optical cavities. Output intensities of 1 $MWcm^{-2}$ have been produced with 3 mJ output energy, a spectral linewidth better than $5x10^{-3}$ nm and an injection locking efficiency of 0.9.

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