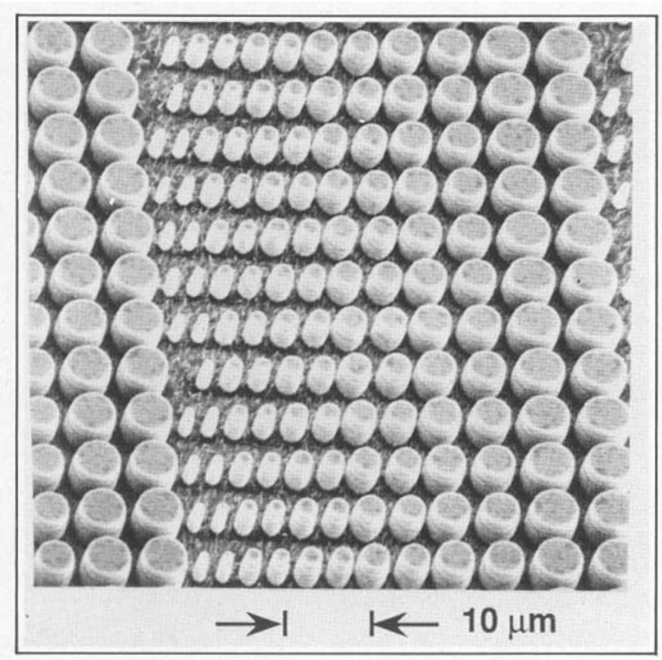

Scanning electron micrograph of a small portion of the µ-laser array.

were obtained despite very short carrier lifetimes due to surface recombination on the sidewalls. The highest power obtained so far was 170 m W pulsed (4 mW average) from a 100 µm square region. We have also modulated the SQW 10-µ-square lasers with pseudorandom pulses at 1 Gb/sec yielding $<10^{-10}$ bit error rates. Smaller µ-lasers should be capable of much higher speeds.

This was our first attempt to realize ultra-small micro-lasers. Reduction of optical absorption in the cavity and suppression of surface recombination should allow further volume reductions to <0.01 μm^3 active material and thresholds less than 10 µA.

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Single and multiple element 4-pass phase conjugate master oscillator power amplifier using diode lasers

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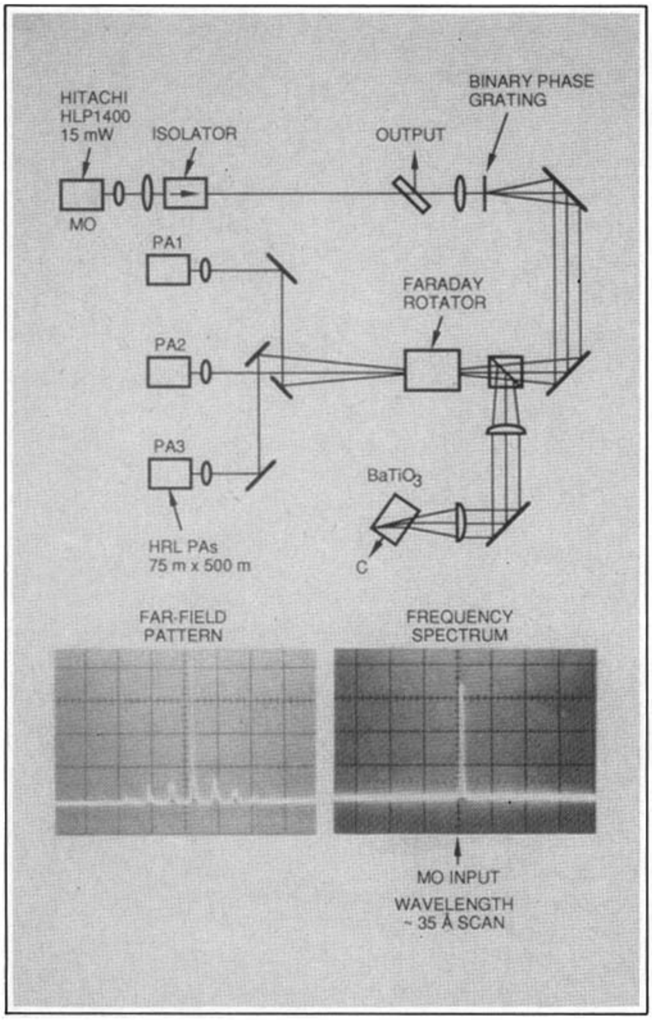
Scaling laser diodes to high optical powers demands large emission apertures. Simple broad-area structures or laser diode arrays suffer from degradation of both the spectral and spatial mode as the emitting aperture increases in size. In addition, when multiple elements are combined, proper phasing is a difficult and sometimes impossible task.

We have demonstrated laser diode based phase conjugate master oscillator power amplifier (PC MOPA) systems as an alternative for power scaling.[1] In a PC MOPA, a relatively low power master oscillator with good beam quality is passed through one or many large area power amplifiers. After optical phase conjugation on the amplified beam(s), any linear aberrations due to either the optical system or the amplifier(s) are corrected by a second pass through the material. A second property of a PC MOPA system is that multiple amplifiers that are physically separated can be phased with no need to provide interferometer path length matching. Provided that the phase conjugation for the different amplifiers takes place in the same nonlinear interaction, all path length differences accumulated on the first pass will be removed on the second pass.

We have demonstrated a new 4-pass PC MOPA geometry that more readily allows for efficient heat sinking of the diode amplifiers than previous work. We also phased three discrete amplifiers yielding a single lobbed diffraction limited output beam with the spectral properties of the master oscillator. In single amplifier experiments, output powers as high as 100 mW have been obtained.

The geometry used in the 4-pass PC MOPA experiments is shown in the figure. The master oscillator (MO) is a commercially available GaAs/GaAlAs buried heterostructure laser that operates in a single spatial and spectral mode. The beam from the MO is split into three beams by a binary phase grating, then reshaped and focused into the amplifiers for the first two passes. After these passes, the polarization is rotated by the half-wave plate and Faraday rotator so that the beam splitter deflects it to the conjugate arm of the system. The conjugate return then passes through the amplifier for passes three and four reforms at the phase grating and exits the system. The polarization on the first two passes is perpendicular to the junction of



4-pass PC MOPA experimental apparatus and far-field output.

the amplifier, exciting the lower gain TM modes in the waveguide. On passes three and four, the polarization is parallel to the junction exciting the TE modes. This choice of polarization order has the advantage of less power dissipation at the conjugate crystal leading to higher overall efficiency.

The amplifiers used were broad-area double heterostructure design grown by low pressure MOVPE. The active area was a gain guided region 75 μm wide and 500 μm long. The back facet was coated with a quarter wavelength Si/Al_2O_3 six-layer high reflectivity stack that was measured at greater than 95%. An Al_2O_3/ZrO_2 two-layer coating designed to give a minimum reflectivity was used on the front facet. During deposition of the second layer of the coating, the lasing threshold of the amplifier was continuously monitored and the process was stopped when the threshold reached a maximum. Measured values of the reflectivity obtained by this technique ranged from 0.1% to 0.01%. The phase conjugate return was generated in a 5 mm cube of barium titanate used in an internally self-pumped geometry. The conjugate reflectivity was measured to be approximately 65%.

The far field profile of the three-element PC MOPA is shown in the figure. The side lobes are due to leakage of spontaneous emission back through the phase grating. The main central lobe is diffraction limited for a 75μm aperture. Spectrally, the output matches that of the master oscillator. The output shows that the three amplifiers have been added in phase and any aberrations present in them have been corrected by the conjugate crystal.

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NONLINEAR SYSTEMS

Optical switching in polydiacetylene-based directional couplers

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Waveguide directional-coupler devices have been fabricated from thin films of solution-processible polydiacetylenes.[1–3] When operated at a wavelength of 1.06 μm, these devices exhibit a variety of nonlinear transmission and switching phenomena due to both fast electronic and slow thermal nonlinearities in the polymer.[1] Such results, obtained on prototype device structures, give important information on the operating conditions and constraints relevant for future polymer based on nonlinear optical devices.

Nearly a decade ago, it was realized that the large third order optical nonlinearities of organic conjugated polymers, such as polydiacetylenes, might be used in all-optical signal processing devices.[4,5] Until recently no such devices had been developed and important questions concerning