UNIVERSITY OF ROCHESTER
LABORATORY FOR LASER ENERGETICS

Volume 62
January–March 1995
DOE/SF/19460-75

LLE Review

Quarterly Report

UR LLE

Contents

In Brief

This volume of the LLE review, covering the period of January–March 1995, contains articles on the evaluation of the mechanism for laser damage in OMEGA UV multilayer coatings using a combination of conventional laser-damage characterization methods and atomic force microscopy; a dual-amplitude, fiber-coupled waveguide integrated-optic modulation device for generating temporally shaped optical pulses in OMEGA; a proposal for modifying the indirect-drive irradiation geometry of the National Ignition Facility (NIF) to provide the additional flexibility for performing direct-drive experiments; direct measurements of terminal-level lifetime in several different Nd:YLF laser media; an overview of the materials science issues, basic mechanisms, and potential device applications for light-emitting porous silicon; and a study of the time-dependent reflection and surface temperatures for laser-irradiated dental hard tissue at two CO_2 laser wavelengths.

Highlights of the research presented in this issue are

- Submicron, lateral-sized craters that develop independently of the presence of micron-scale growth nodules and whose number density follows the intensity profile of the full laser beam appear to be the dominant damage feature in UV high-reflector coatings. Coupled with the observation that the smallest measured craters allow for starting absorber sizes of <10 nm, these results point toward randomly distributed nano-cluster absorbers as the sources involved in the energy transfer from the optical field to the porous film medium.

- An optical pulse-shaping system employing integrated-optic amplitude modulators operated in series and fabricated on a single, fiber-coupled $LiNbO_3$ waveguide has been designed. This system is capable of meeting future pulse-shaping requirements for the OMEGA laser. In recent operational testing, this system has demonstrated the ability to produce shaped optical pulses with 50- to 100-ps structure over a pulse envelope of several nanoseconds.

- Highly uniform irradiation for *direct*-drive experiments can be produced by NIF if its design is modified to allow one-half of the beams to be redirected to new ports closer to the equator of the target chamber and if 2-D SSD with polarization dispersion is implemented. The tolerances for energy imbalance among the beams, beam mispointing, and errors in target positioning will depend on how much long-wavelength nonuniformity the target can accept without a serious degradation in performance.

- The terminal-level lifetimes for four different Nd:YLF samples as determined by small-signal-gain and transient excited state absorption measurements were found to be considerably longer than the pulse lengths encountered in mode-locked laser operation and amplification of up to nanosecond pulses. Because the terminal-level-laser lifetime in these media approaches the length of a common Q-switched laser pulse, simple analytical models are inadequate to account for terminal-level relaxation during amplification of such pulses, and numerical solutions will be required in order to calculate energy-extraction performance.

- Room-temperature photoluminescence with an efficiency between 0.1% and 10% has been demonstrated in porous silicon, and its luminescence spectrum, intensity, and lifetime have been shown to be highly sensitive to growth and processing parameters. The ability to vary the peak of the photoluminescence spectrum from the blue/violet to wavelengths past 1.5 μm makes these materials of interest in the fabrication of light-emitting devices (LED's) operating over the same wavelength range.

- The first experimental evidence of time-dependent reflection in dental hard tissue irradiated with a 9.6-μm, CO_2 laser has been observed and is related to the temperature dependence of the absorption coefficient using known relationships between surface reflection and high absorption coefficients. These results indicate that morphological surface modifications in dental hard tissue can be fine-tuned by making an appropriate choice of wavelength and pulse duration, which would allow optimization of the laser-irradiation conditions for the reduction of dental decay.

Kenneth L. Marshall
Editor