have also been derived. Both designs result in thicknesses larger (smaller) than one QW for the low-index (high-index) material.

Whether or not these modified designs will yield higher thresholds than the all QW-layer design depends on the ratio ρ of the damage thresholds of the low-and high-index films. If $\rho \geqslant n$, then the two-layer modification is preferred over an all QW design. (At $\rho = n$ damage will occur simultaneously in the top low- and high-index films.) If $\rho \geqslant \sqrt{2n^2 - 1}$, then the 4-layer modification is the better design. For TiO_2/SiO_2 reflectors we have measured ρ to be 1.5 to 1.6 for 30-ps pulses at 1064 nm.

To properly evaluate the advantages of the 2- and 4-layer modifications over the all-QW design, reflectors of TiO_2/SiO_2 (index ratio = 1.64) of each design were fabricated in a single coating run by appropriate shuttering and film thickness monitoring techniques. Thus, except for the top 2 or 4 layers the reflectors experienced identical conditions. Each reflector was exposed to a series (55) of single 30-ps pulses at 1064 nm, and the thresholds are listed in Table I.

TABLE I

Reflector Design	Energy Density
	J/cm^2
A. 15 QW's	4.5–5.4
B. 13 QW's	
+2 non-QW's	4.5–8.0
C. 11 QW's	
+4 non-QW's	4.5–6.4

The upper (lower) end of the threshold range was defined as the maximum (minimum) pulse energy for which damage was not (was) detected. It is seen that the lower values are identical, whereas the upper values vary significantly. The same value of 4.5 J/cm^2 for the low end is attributed to coating defects in the top TiO_2 film damaged by the first-pass traveling-wave field (at 4.3 MV/cm before a SW pattern was established). The upper thresholds of reflectors B and C were 48% and 18.5% greater than that of reflector A. Improvements of 58% and 102% would have been expected if high-index failure would have occurred first, However, the respective electric fields in the top SiO_2 layers of reflectors B and C at the threshold flux were 10.6 and 10.5 MV. We concluded that low-index failure determined the threshold for these designs. This was consistent with the theory since $\sqrt{2n^2 - 1} > \rho$ and n was also slightly larger than ρ. Thus, the 2-layer modified design provided near maximum improvement for these materials. Total realization of the benefits of non-QW designs will occur when defect-free films can be produced.

11.11 Neodymium Glass Laser Systems for Laser Thermonuclear Research (*Invited*), P. P. Pashinin, *Lebedev Physical Institute, Academy of Sciences, Moscow, U.S.S.R.*

(*30* min)

No summary.

Session 12

Thursday, June 2, 1977 **1:30-5:00 P.M.**

Nonlinear Optical Devices

Chairperson: J. F. Young

Organizer: C. C. Wang

12.1 A Passive Contrast Enhancer for Ultrashort Pulses in High Gain Amplifier Systems, K. Sala and M. C. Richardson, *National Research Council of Canada, Division of Physics, Ottawa, Canada*

(*15* min)

An aspect central to all large ultrahigh power short pulse laser systems, employing many amplifiers, is their effective gain isolation, and the inhibition of small signal parasitic buildup. Current approaches employ electrooptic and magnetooptic shutters or the use of various types of intensity dependent saturable filters.

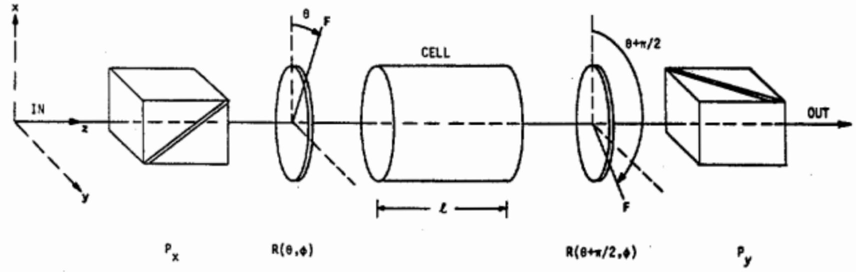
In this presentation we describe a new type of gain isolator which also has a very large range of intensity dependent nonlinear transmission, making it an attractive ultrashort pulse contrast enhancement element in multiamplifier systems. Unlike saturable dye small signal gain isolators, it is not wavelength dependent, and consequently becomes a candidate as a small signal gain isolator and short pulse contrast enhancer for potential high gain UV laser systems. Demonstration of its effectiveness in optical filtration of low level baseline noise accompanying a single picosecond duration pulse from a Nd:glass laser is made.

This passive contrast enhancer (PCE) is based upon the phenomenon of self-induced ellipse rotation. The device employs two retardation plates, having identical retardances, situated around an optical Kerr cell. To provice polarization selectivity, these elements are placed between crossed polarizers as shown in Fig. 1. Consider an input optical signal composed of a single intense picosecond pulse accompanied by pre- and post-pulse optical radiation such as is normally observed through electrooptic pulse selection gates. Under optimum conditions of wave plate orientation and Kerr cell length, the main pulse is effectively transmitted. However, the weak pulses cannot induce the same degree of ellipse rotation and are preferentially rejected. The degree to which the transmitted pulse is enhanced over the baseline radiation can be exceedingly large ($> 10^4$) and is only limited by the rejection ratio of the polarizers. These devices are inherently aperture scalable, and can be used in series to provide exceedingly high contrast ratios.

A generalized analytical model of the device will be described in conjunction with experiments performed with a single picosecond pulse derived from a mode-locked Nd:glass laser. Utilizing a single PCE, contrast enhancement factors in excess of 10^5 and transmission factors of ~ 0.45 were obtained for an input pulse energy of ~ 4 mJ, in close agreement with theoretically predicted values. With two PCE's in series, which theoretically have a contrast factor of $> 10^9$, measured enhancement factors $> 4 \cdot 10^6$ were detection limited with transmission factors of $\sim 20\%$.

The applicability of this device to other potential high gain short pulse amplifier systems will also be discussed.

Fig. 1.



12.2 Detection of Infrared Signals by Nonlinear Optical Mixing Dye Laser Radiation in $AgGaS_2$, W. Jantz, P. Koidl and R. Schätzle, *Institut f. Angewandte Festkörperphysik der Fraunhofer-Gesellschaft, Freiburg, W. Germany*

(*15* min)

It is well known that a powerful laser of frequency ν_2 and a nonlinear medium allows conversion of infrared signals at frequency ν_1 into a signal at frequency $\nu_3 = \nu_1 + \nu_2$ where the "upconverted" signal ν_3 can be more sensitively detected. We have built and operated such a detection system for converting middle infrared radiation, in particular CO_2 laser radiation, directly into the visible (green) spectral range. It is designed to optimize all relevant system parameters. Power conversion efficiencies exceeding 100% have been obtained with moderate laser power. The detection is inherently high speed, narrow band (3 cm^{-1}), widely tunable and operates at room temperature.

The apparatus is sketched in Fig. 1. $AgGaS_2$, a ternary semiconductor, has a wide transparency range (0.5–11 μm) and a high nonlinear coefficient (43 × KDP). The effective nonlinear coefficient and thus the conversion efficiency is maximized for 90° phase matching, a geometry simultaneously offering maximum acceptance angle, no walkoff, arbitrary crystal length,