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ABSTRACT

Transient absorption in optical fibers was studied with 2 ns resolution. The data show a very fast absorption peak (with little temperature dependence) superimposed on a slow, temperature dependent, recovery.

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Optical fibers are known to exhibit transient luminescence and absorption when exposed to radiation.¹ Previous studies¹⁻³ have obtained data under pulsed conditions, but no experiments have explored transient absorption in the time range below 50 ns. In this study, data will be presented from 0-100 ns with a time response below 2 ns for a variety of fiber types and temperature conditions.

At the short time of interest in this study, damage mechanisms (tunneling, geminate recombination, traps) important at longer times do not predominate. The goal of this study is both to provide a consistent data set at very early times and to test other possible theories of absorption mechanisms.

EXPERIMENT TECHNIQUES

Pulsed lasers are used to produce light pulse coincident with an electron pulse from a Febetron 706. The Febetron output is filtered to strip low-energy electrons from the beam providing a FWHM of 1.4 ns. The recording system time response was about 1.0 ns. An oven allowed fiber temperature to be raised to 200° C.

TRANSIENT ABSORPTION MEASUREMENTS

In Fig. 1, an attenuation measurement with a 200-KRad dose on ITT PCS fiber (T303 with Suprasil core) is displayed. Room temperature was used. The bars in Fig. 1 refer to data from multiple shots.

Similar data were acquired at elevated temperatures. The use of the oven altered the geometry such that 100 kRad dose was obtained. In Fig. 2, a composite of data at two temperatures is presented.

DISCUSSION

From Fig. 2, we note that the initial absorption peak is affected only slightly (15%) with a temperature change from 20° C to 195° C. The very slight temperature dependence of the initial peak absorption precludes any model depending on a diffusion or thermal trapping process. The slow, later time, portion of the absorption curve is strongly temperature dependent and a two-parameter fit with a geminate recombination model⁴ is shown in Fig. 1. The data of Fig. 2 and the theoretical fit in Fig. 1 argue strongly that at least two distinct processes are present. One fast process may lead to the peak absorption while a much slower (geminate-recombination) process may lead to the slow, temperature-dependent, absorption tail.

The origin of the prompt absorption peak is not yet understood. Very fast atomic processes may explain the phenomena.

FUTURE WORK

The data recording system has been reconfigured with a faster recording system (FWHM 400 ps) and a new dye laser will provide a tuned output from 600 to 850 nm.

Data will be acquired at 600 and 800 nm at several dose rates and temperatures. Both elevated and cryogenic temperatures will be used. Several fiber types, in addition to PCS, will be tested. Data will be presented at the conference.

Very preliminary data suggest dramatically decreased prompt absorption at 800 nm in PCS fiber.

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Fig. 1. Attenuation measurement (data bars) for ITT PCS fiber. Solid line is two parameter fit using geminate recombination theory (Ref. 4).

Fig. 2. Attenuation measurement of ITT PCS.