width of the DPSK-modulated signal the minimum channel spacing is approximately 15 times the bit rate. In our experiments we used a single detector receiver. Its square law characteristic leads in a multichannel system to the generation of intermodulation products.[7] Owing to the large LO power the wanted IF signal of CH1 is large compared to the unwanted CH1-cross-CH2 signals, so that these spectral components are neglectable. Our experiments demonstrate that for the given pulse shape and receiver filter the minimum channel spacing is only seven times the bit rate.

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PHOTOCHROMIC DYNAMICS AND NONLINEAR TRANSMISSION AT MODULATED CW BLUE/GREEN WAVELENGTHS IN GERMANOSILICATE OPTICAL FIBRES

Indexing terms: Optical fibres, Optical transmission, Optical properties of substances

Photochromic dynamics in germanosilicate fibres at quasi-CW blue/green wavelengths are investigated using sinusoidally modulated Ar^+ laser light. The induced loss has both transient and permanent features, and gives rise to strongly nonlinear transmission.

Introduction: Many fibre-based devices exist that rely on the ability to transmit high optical intensities through single-mode fibre. Examples are fibre lasers, amplifiers, second harmonic generators or any fibre-based high-power delivery system. Thus it is a cause of some concern that Brown *et al.*[1] reported strong nonlinear effects at Ar^+ laser wavelengths which limited the transmitted power to some tenths of a watt over short (several metre) lengths of fibre. We recently presented[2] the preliminary results of an extensive investigation into this behaviour in germanosilicate (GS) fibres subjected to pulsed radiation in the blue/green region of the spectrum. In those experiments peak powers of ~50 W at average powers of ~10 μW were employed. Here we report the behaviour at quasi-CW power levels of ~1 W slowly modulated at frequencies of up to 1 Hz.

We have explained[2] nonlinear transmission (NLT) in fibres by postulating colour-centre creation via two-photon absorption and annihilation via both spontaneous and single-photon bleaching. The physical basis for this picture is as follows. Two-photon absorption breaks the Si–Ge and Ge–Ge bonds characteristic of oxygen-deficient germanosilicates,[2] releasing electrons with sufficient energy to drift through the glass matrix along networks of interconnected Ge centres (narrow band-gap 'electron pathways'), eventually either recombining or being trapped at other Ge sites to form Ge(1) or Ge(2) colour-centres.[3] Single-photon absorption and spontaneous bleaching release electrons from these traps back into the electron pathway where they are free to recombine or get trapped elsewhere. It is the complex interplay of these processes that leads to steady-state colour-centre populations that scale with the optical intensity. If the intensity is modulated, the colour-centre populations do not in general have time to reach equilibrium, and the temporal behaviour of the loss is more complex.

This is the aspect of the phenomenon that we have chosen to investigate here, for it is of experimental interest to know how a fibre will behave when subjected to quasi-CW excitation, i.e., repeated cycling up and down of the intensity at low frequencies.

Experiments: In our experimental set-up we measured the loss in the fibre during and after exposure using a counter-propagating white-light signal. This is more accurate than calculating the loss from the transmitted laser power since as the laser output power is increased, the launch efficiency tends to fall owing to the gradual appearance of the TEM^*_{01} mode. Also, this system meant that the induced loss could be monitored without disturbing the colour centres, enabling measurements to be made when the laser was blocked. A recurrent problem with all experiments of this sort is instability and drift in the launching of the laser light into the fibre. The best possible coupling efficiencies are desirable, and these are only obtainable with a tightly focused beam which of course renders the launch highly sensitive to small vibrations and creep. We solved the problem using a feedback controlled launch optimiser from York Harburg Sensors and obtained excellent long-term stability even at high power levels with launch efficiencies of ~30%. The laser power was then modulated electronically at different frequencies.

Results and discussion: The NLT measured by Brown *et al.*[1] was approximately reversible, the fibre loss reverting to its initial level as the light intensity I was reduced to zero. Their data were taken after equilibrium had been reached at each new intensity level; the behaviour is substantially different when I is modulated.

The loss induced in 5 m lengths of single-mode bow-tie high-birefringence fibre (NA = 0·17) subjected up to 70 mW/μm^2 at 488 nm, modulated at various frequencies, is shown in Fig. 1. It should be noted that in all the experiments the loss is measured at 540 nm, and that at 488 nm this value will be approximately doubled. At each frequency the mean induced loss rises gradually, eventually saturating to a steady level. At the lowest frequency, the loss cycles strongly up and down, in phase with the optical signal. As the frequency is increased, the loss is modulated more weakly and gradually becomes out-of-phase with the driving signal. At the highest frequency no detectable ripple appears on the loss, which gradually approaches a steady-state level, resulting in an effectively linear transmission, although more lossy than in an unirradiated fibre.

After blocking the laser (a steady-state transmission level having been reached), relaxation processes cause the loss to evolve further to a new steady-state level higher than the one attained in the presence of the laser light (see Fig. 2). This new loss level depends on the input power prior to blocking; it bleaches out when the laser is unblocked again, the loss returning to its previous steady-state level. In our model, the relaxation processes behind this behaviour are the result of electrons in the electron cloud recombining with broken

Ge–Si and Ge–Ge bonds and being thermally redistributed amongst the different types of trap.

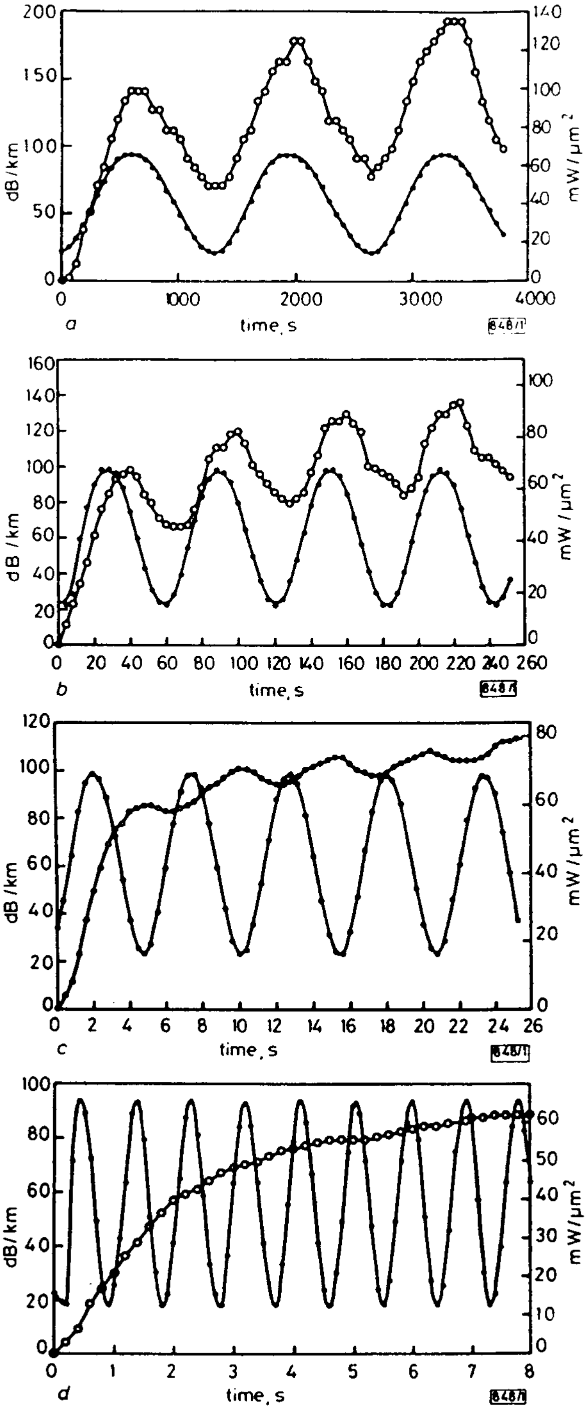

Fig. 1 *Induced loss in fibre subjected to input intensities modulated at given frequencies*

a 0·0008 Hz *b* 0·02 Hz *c* 0·2 Hz *d* 1 Hz
—●— input intensity —○— loss induced at 540 nm

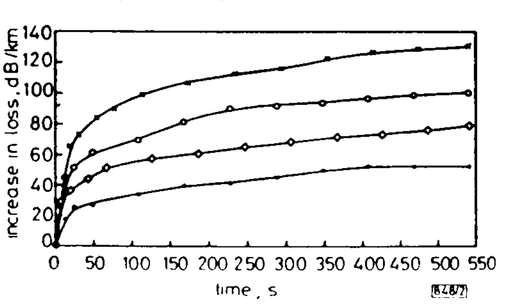

Fig. 2 *Further increase in loss after blocking laser*

Prior to blocking laser, input powers and steady-state induced losses at 540 nm were as follows:
■■■ 0·2 W, 75 dB/km
+ + + 0·4 W, 132 dB/km
◇◇◇ 0·6 W, 206 dB/km
○○○ 1 W, 300 dB/km

Conclusions: Subjecting a germanosilicate fibre to repeated cycling up and down of the optical intensity at frequencies of up to 1 Hz results in an induced photochromic loss which can exceed the intrinsic loss by more than an order of magnitude. At low frequencies ($\sim 10^{-3}$ Hz) the loss is modulated in phase with the optical signal. As the frequency is increased the loss is modulated less strongly (3 dB point at $\sim$0·008 Hz) and gradually becomes out of phase until at 1 Hz there is no detectable ripple. If the laser is blocked, spontaneous relaxation processes in the glass cause the loss to increase to a new level dependent on the input power prior to blocking.

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HANDLING ISOCHRONOUS AND NON-ISOCHRONOUS TRAFFIC IN LOCAL AREA NETWORKS

Indexing terms: Digital communication systems, Networks, Data transmission, Communication networks

A token ring network is described that integrates isochronous and non-isochronous services at the medium access layer. It guarantees an upper bound on the transport delay of isochronous information units, together with a lower bound and a fair allocation of the bandwidth for non-isochronous traffic.

Introduction: The integration of isochronous services (e.g. video and voice service), or i-services, with non-isochronous services (e.g., data services), or n-services, in a single communication network is a key goal in the deployment of a cost-effective multiservice transport system. This goal is easier to achieve in limited geographic areas than in nationwide areas, owing to the widespread adoption of LAN technology for the transport of data traffic. In fact, a service integration at the medium access layer makes it possible to take advantage of most of the equipment already deployed.

Different network topologies and access protocols for service integration have been proposed, e.g. References 1–4. We specifically address the problem of service integration in fast networks, say, on the order of 100 Mbit/s, covering a small-to-medium geographical area, say, spanning up to a few tens kilometres. This range of network size suggests the adoption of a ring topology, in which the signal is regenerated in each station, and conflict-free access schemes. Furthermore, our adoption of a variable size for the i-service information units, to be discussed later, makes a token passing scheme the most reasonable procedure for the access permission transfer. Indeed, slotted access schemes, which have also been proposed for ring networks,[1,3] would imply an efficiency loss with variable size information units.