Invited Paper at International Conference on Materials for Non-Linear & Electro-Optics, Girton College, Cambridge, July '89

GLASSES FOR NON-LINEAR OPTICS

D.N. PAYNE
OPTICAL FIBRE GROUP,
DEPARTMENT OF ELECTRONICS & COMPUTER SCIENCE,
THE UNIVERSITY OF SOUTHAMPTON,
HAMPSHIRE, SO9 5NH

ABSTRACT

Although glasses have relatively-low non-linear coefficients, the advent of low-loss guided-wave structures such as optical fibres allows this disadvantage to be offset by the use of long interaction lengths and very high optical intensities. Most work to date has concentrated on silica fibres which are readily available but have a particularly low third-order non-linearity, as well as poor electro- and magneto-optic coefficients. Recently, however, it has been discovered that by appropriate doping of silica and operating in the blue region of the spectrum, defects in the glass can be excited which impart photochromic and photorefractive properties. If aligned (poled) by an electric field, the defects also give rise to substantial second-order non-linearities and allow second-harmonic generation and Pockels effects.

Abandoning silica altogether in favour of high-index compound glasses can result in an order of magnitude or more improvement in the non-linear coefficients. Furthermore, the addition of semiconductor microcrystals and rare-earth dopants can have profound effects on the glass properties.

Perhaps the largest non-linearity of all can be found in the rare-earth-doped fibre lasers and amplifiers which are now being developed for optical telecommunication. These devices can exhibit bistability, soliton generation and simultaneous intra-cavity upconversion. Of equal importance, they provide the means to convert low-level diode-laser radiation into intense optical pulses of sufficient magnitude to allow practical non-linear switching in glass-waveguide devices.

The review will concentrate on novel glass materials for non-linear waveguide devices and describe a number of novel effects which can be induced.