PREFACE

In recent years, chalcogenide glasses have established their usefulness as attractive candidates for the fabrication of all-optical devices and mid infra-red lasers. These glasses possess low phonon energy and hence high luminescence quantum efficiency, which make them suitable for fabricating active photonic devices. Further, chalcogenide glasses exhibit a variety of photo-induced phenomena upon irradiation with energies above band gap under suitable conditions; the energy deposited at the focal point creates a localized refractive index change which can be used to fabricate a dielectric channel waveguide by translating the material through the laser focus.

In this thesis work, different chalcogenide glasses have been prepared by melt quenching technique and their response to irradiation with ultrafast laser pulses has been studied. Photosensitivity studies undertaken have shown that the shape and magnitude of the index profile strongly vary with irradiation conditions. An optimal waveguide by ULI is the result of the successful interplay of a variety of inscription parameters that depend on the inscription laser, steering & focusing optics, translational stage parameters and the material under study. Thus, the waveguide properties can be tailored by optimizing these inscription parameters.

The optical characterization of ultrafast laser inscribed, single-scan, as well as multi-scan waveguides, has been carried out at 1550 nm. The multi-scan technique reduces the number of scattering and absorbing defects induced in the modified material by the inscription process, hence reducing the optical losses. Mechanical and structural characterization has been carried out on ultrafast laser inscribed waveguides by nanoindentation and micro-Raman spectroscopy. Nanoindentation studies on single-scan waveguides show a position dependent mechanical behavior in the photo-modified region. At the laser focus, the photo-modified region exhibits same mechanical properties as those of bulk glass. This observation indicates that the material is getting quenched during re-solidification after waveguide inscription. At top of the waveguide, which is away from the focus, the elastic modulus and hardness are reported to be lower than bulk indicating the material is getting annealed at this region. This position dependent mechanical behaviour is correlated with the structural changes using micro-Raman studies.

Nanoindentation studies undertaken on multi-scan waveguides reveal lower elastic modulus and hardness values compared to the bulk glass. The lower pulse energy and longer thermal accumulation during multiple passes cause annealing in the photo-modified region. Micro-Raman studies show a decrease in network connectivity in the photo-modified region resulting in lower mechanical properties. The change in mechanical properties in the photo-modified region is found to be greatly influenced by the net-fluence used for waveguide fabrication. The waveguides fabricated at different net-fluence show different local structures as a result of different rates of localized heating/cooling, which determine bond order and the local structure in a glassy network.