combination of recovery time reduction and degradation in linear loss seems to be the best thus far reported for the proton bombardment technique [39].

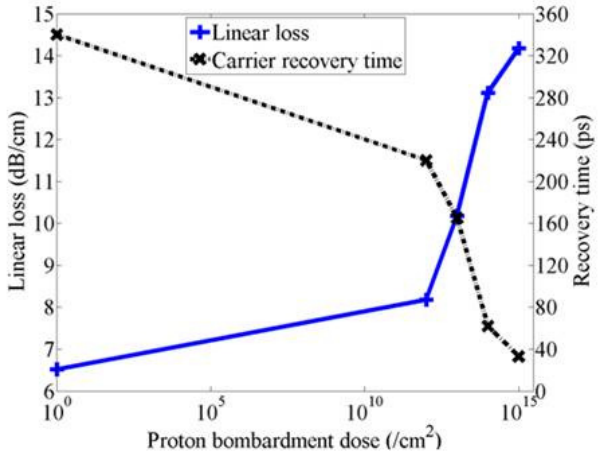

Fig. 11. Linear loss and carrier recovery time as a function of the proton bombardment.

6. Conclusion

In this paper, the ultrafast nonlinear optical properties of high-index contrast silicon waveguides of 106nm×475nm cross-section were studied. Input and output optical coupling was accomplished using lens-tip fibers, and both cut-back to determine propagation loss and forward-backward nonlinear measurements were used to determine individual coupling losses. A measured 5.6 dB difference between the coupling efficiencies at the input and output ports demonstrated the importance of such measurement to determine the internal optical pulse energy accurately. The heterodyne pump-probe technique was utilized to characterize the magnitude of the TPA and FCA losses as well as the Kerr nonlinearity and the refractive index change as a function of the carrier density. The high sensitivity of the heterodyne technique has allowed for this characterization with only relatively small induced carrier densities. The two-photon absorption coefficient and free-carrier absorption effective cross-section were determined to be 0.68cm/GW, and $1.9\text{x}10^{-17}$ cm^2, respectively and the Kerr coefficient and free-carrier-induced refractive index change $0.32\text{x}10^{-13}$ cm^2/W, and $-5.5\text{x}10^{-21}$ cm^3, respectively. The parameters extracted were applied to a model predicting the output power response of the waveguides as a function of the input power. This model was utilized to predict the limitations imposed by the nonlinearity on the transmission of pulsewidths of different duration [47]. As the carrier recovery of silicon can be in the order of several hundreds of picoseconds to nanoseconds, the devices were proton bombarded with different doses to determine the relationship between reduced lifetime and induced additional loss. Carrier lifetime of 33ps with proton bombardment level of 10^{15} /cm^2 with an increase of linear loss to 14.8dB/cm was achieved.

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