slight increase in Sb-content and decrease in Ge-content in our fabricated waveguides compared to the bulk.

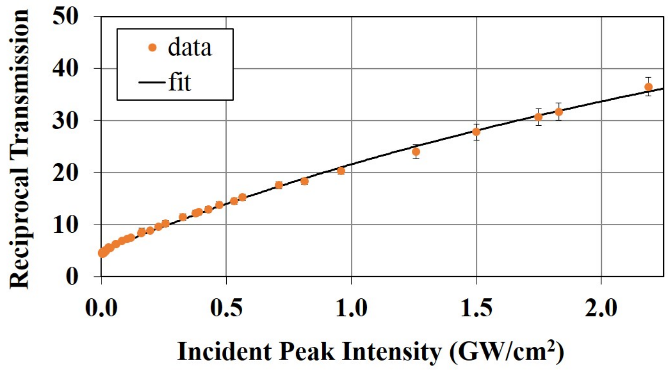

Fig. 5. Plot of reciprocal transmission as a function of incident peak intensity for a single-mode Ge-Sb-Se waveguide. The average effective two-photon absorption coefficient of the waveguide is measured to be 11.5 ± 0.7 cm/GW.

The input and output spectra from our waveguides were also measured, revealing a weak, power-dependent broadening of the spectral full-width at half-maximum (FWHM). Estimates of spectral broadening from split-step numerical solutions to the Nonlinear Schrödinger Equation, using the expected effective n_2 for the waveguide and measured β_{wg} with saturation, suggest the changes in FWHM are predominately due to β selectively decreasing the high-intensity peak of the pulses, making accurate determination of n_2 for the waveguide difficult.

5. Conclusion

In summary, we fabricated single-mode, air-clad, strip Ge-Sb-Se waveguides with similar composition and properties to bulk $Ge_{28}Sb_{12}Se_{60}$ glass. In bulk, using a reduced 374 KHz repetition rate, $n_2 = 3.4 \pm 0.4 \times 10^{-18}$ m^2/W and $\beta = 3.5 \pm 0.2$ cm/GW. In the waveguides, the linear loss, 11.9 dB/cm on average, was dominated by scattering loss. The nonlinear loss of the fabricated waveguides was 11.5 cm/GW, reasonable considering the enhanced value of β with the 37.4 MHz repetition rate, the overlap of the mode with the waveguide structure, and slight variations in composition. We expect changes in waveguide geometry to increase the power confined in the chalcogenide core can help to both reduce the effect of scattering loss and increase the effective nonlinearity of the waveguide.

Although two-photon absorption for the bulk and the waveguides is large at 1 μm and will limit the realm of nonlinear device applications in this wavelength regime, Lenz et al. have shown that the figure of merit improves substantially at 1550 nm, farther from the band edge of the material [44]. In the future, we plan to optimize, fabricate, and characterize Ge-Sb-Se waveguide devices at 1550 nm and 3000 nm, where we anticipate the material will not suffer from large nonlinear absorption.

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