4. Conclusions

The linear and nonlinear coefficients from the hydrogenated amorphous silicon photonic nanowires were extracted in this paper. The linear absorption was found to be 3.6 dB/cm while the nonlinear parameter was found to be $\gamma = 770 - j28\ W^{-1}m^{-1}$ after exposing the waveguides for 30 minutes. This results in a figure of merit larger than 2. The carrier lifetime was estimated to be 1.87 ± 0.1 ns. The potential of the a-Si:H photonic nanowires for all-optical nonlinear processing was demonstrated by a 320 Gbit/s waveform sampling experiment. The intrinsic FWM conversion efficiency in this experiment was + 12 dB. This is an improvement of 19.5 dB as compared to similar sampling experiments in c-Si [19]. The degradation of the hydrogenated amorphous silicon layers is discussed. This degradation is presumably caused by a process similar to the Staebler-Wronski effect in amorphous silicon solar cells. As with the Staebler-Wronski effect in amorphous silicon cells, the degradation can be reversed by thermally annealing the sample. This was demonstrated by heating the sample for half an hour at 200 °C. Improving the stability, for example by increasing the bandgap, could make the hydrogenated amorphous silicon photonic nanowires the platform for nonlinear integrated optics in the telecommunication wavelength range.

Acknowledgments

B. Kuyken acknowledges the Flemish Research Foundation, Vlaanderen for a doctoral fellowship. This work was partly carried out in the framework of the Methusalem "Smart Photonic Chips," FP7-ERC-INSPECTRA and FP7-ERC-MIRACLE. We acknowledge support by the Interuniversity Attraction Poles Photonics@be Program (Belgian Science Policy) under grant IAP6-10.

#155813 - $15.00 USD Received 30 Sep 2011; accepted 17 Oct 2011; published 17 Nov 2011