Nonlinear applications in the mid-infrared regime based on germanium on silicon platform

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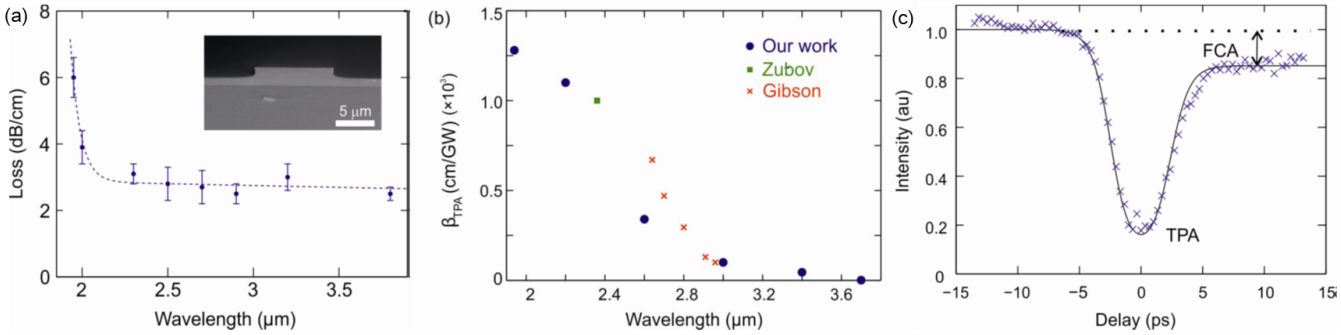
Abstract-This abstract reviews our progress in characterizing nonlinear properties of low loss germanium-on-silicon waveguides in the mid-infrared wavelength. All-optical modulation is demonstrated in these waveguides and indicates the suitability of this platform for nonlinear applications in this long wavelength regime.

Group IV mid-infrared photonics is currently attracting considerable attention for applications in gas sensing and spectroscopy. Recently, low loss germanium-on-silicon (Ge-on-Si) waveguides have emerged and have been demonstrated to have advantages in the mid-infrared wavelength regime, e.g. broad transmission window and CMOS compatible [1]. Here we review our progress in characterizing the nonlinear transmission properties of the Ge-on-Si rib waveguides and demonstrate the first ultrafast all-optical modulation in these waveguides.

Our Ge-on-Si waveguides were fabricated using lithographic patterning and reactive-ion etching methods and have an etch depth of 1.2 μm and a core width of 2.25 μm [2]. The rib structure is shown in the inset of Fig. 1(a). A summary of the loss measurements taken by an effective cut-back method over the wavelength range 1.9-3.8 μm is provided in Fig. 1(a). Fig. 1(b) plots the results of the measured two-photon absorption (TPA) parameter for selected pump wavelengths and the results of bulk germanium by Zubov et al. [4] and Gibson et al. [5]. Fig. 1(c) plots the modulation of the weak probe as a function of delay using a simple pump-probe experiment based on cross-absorption modulation (XAM) process [3]. In conclusion, we have characterized the nonlinear transmission properties of low loss Ge-on-Si waveguides in the 2−3.8mm regime and demonstrated their use for all-optical modulation using XAM schemes.



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