refractive index due to the injected carriers. Ideally we would compare our experimental results with the theoretical analysis of [22]. However, calculations based on the analysis suggest that the free carrier densities achieved over the injection currents used in this work are approximately $1x10^{17}cm^{-3}$, which is out of the range of the minimum densities used to develop the expressions in [22] ($3.2x10^{17}cm^{-3}$ and $5x10^{17}cm^{-3}$ for electrons and holes, respectively). According to the theory, with an injected electron and hole density of $1x10^{17}cm^{-3}$ the attenuation in dB achieved at 1.55µm, 2µm and 2.5µm is 1.7, 2.9 and 3.7 times more than the attenuation at 1.3µm, whereas according to the experimental results of Fig. 2 it is 2.2, 4.5 and 6.3 times more, respectively. Thus we cannot be confident that fitting of the attenuation curves of Fig. 2 with this theory will provide a meaningful interpretation of the results for all four wavelengths.

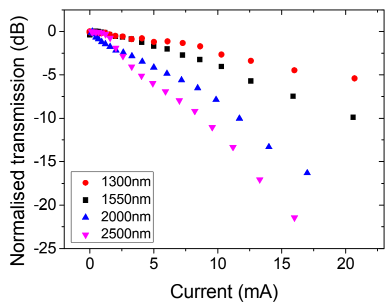

Fig. 2. Normalised transmission versus drive current at 1.31µm, 1.55µm, 2µm and 2.5µm.

The curves of Fig. 2 do, however confirm that as the wavelength is increased the plasma dispersion effect becomes more effective. These results suggest that plasma dispersion effect modulators used for the 2µm wavelength window could be much more compact and/or require a much lower drive voltage (and therefore lower power consumption) than at the traditional NIR telecommunication wavelength bands. The speed of the device used in this analysis is slow due to the large size of the waveguide and the use of carrier injection [28]. By scaling to a smaller waveguide and by using carrier depletion or accumulation techniques, operation at speeds up to 40Gbit/s and beyond can be expected as shown in the NIR [17].

4. Conclusion

Silicon photonic based defect photodetectors and a plasma dispersion effect modulator have been characterised in the 2–2.5µm wavelength band. For the detectors it is shown that operation is possible in this wavelength range, however, the responsivity is reduced as compared to 1.55µm. The results from the optical modulator shows that a large increase in the effectiveness of the plasma dispersion effect is achieved as the wavelength is increased from the traditional telecommunication windows of 1.3µm and 1.55µm to the 2–2.5µm range. These encouraging results show that silicon photonics has bright prospects for the implementation of integrated photonic circuits in this newly proposed short-wave band for extended telecommunications applications.

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