Two-octaves spanning supercontinuum generation in nitrogen-rich silicon nitride

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***Abstract* — Here we experimentally demonstrate two-octave spanning supercontinuum generation in nitrogen-rich silicon nitride waveguides fabricated through backend CMOS compatible processes. Experimental results are in good agreement with our numerical calculations.**

***Keywords* — SiN waveguides; nonlinear optics; photonics; supercontinuum generation.**

I. INTRODUCTION

Supercontinuum generation (SCG) is a third-order nonlinear optical process providing extremely broadband coherent spectra under a pump laser excitation. Over the last decades, the development of SCG devices has paved the way for important advances in spectroscopy, optical coherent tomography and precision metrology to name a few applications. Whereas SCG has been widely studied in the frame of photonic crystal fibers, it is also one of the most promising solutions for ultra-broadband sources at a chip-scale in electronic-photonic integrated circuits (EPIC). Silicon appears to be a suitable candidate with its high third order nonlinearity and the maturity of the silicon platform. However, silicon suffers also from strong Two-Photon Absorption (TPA) and associated free carrier absorption in the near-infrared wavelength range. An alternative solution is to use silicon nitride (SiN). Indeed, thanks to the absence of TPA, SiN can sustain the high power densities needed for SCG without implying losses. Nonetheless, propagation loss in stoichiometric SiN can be high. This can be overcome by increasing the concentration of nitrogen during the deposition process [1]. For the first time we demonstrate two-octave spanning SCG in low-loss nitrogen-rich silicon nitride (N-rich SiN) deposited at low temperature using plasma enhanced chemical vapor deposition (fabrication on 300mm platform in STMicroelectronics facilities).

II. RESULTS

A. Experimental results

Both straight waveguides and spirals were characterized. The fabricated waveguides show low propagation losses (0.4dB/cm). The SCG was experimentally obtained using a femtosecond pulsed-laser pumping N-rich SiN waveguides in the anomalous dispersion regime at 1200nm wavelength. Spectra were measured using an optical signal analyzer and a visible spectrometer. The measured supercontinuum covered the near infrared range up to 1650nm, the whole visible range and near UV range, showing a 570 THz broadening at -30dB. Examples of measured spectra are showed in Figure 1.

B. Numerical simulations

To better understand the experimental results, numerical simulations were performed using a fourth order Runge-Kutta algorithm in the interaction picture to solve the generalized nonlinear Schrödinger equation [2]. Simulation results show that the nonlinear parameter of N-rich SiN is of the same order of magnitude as the one of standard SiN despite a slight increase of effective modal area. Comparison between experimental data and numerical results is shown in figure 1.

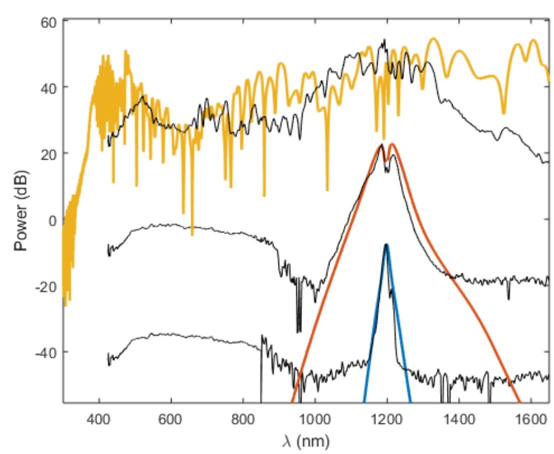

Figure 1: *Experimental (black lines) and simulation (colored lines) results for different input peak powers. From bottom to top: 115W, 440W, 2663W. Curves are voluntarily shifted for better understanding.*

III. CONCLUSION

This paper brings promising results showing that nitrogen-rich silicon nitride is a good candidate for supercontinuum generation in a low loss and backend CMOS compatible platform using low temperature deposition processes.

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