A Visible-Light Foundry Platform from AIM Photonics

Nathan F. Tyndall,[1] Marcel W. Pruessner,[1] Nicholas M. Fahrenkopf,[2] Alin Antohe,[2] and Todd. H. Stievater[1,*]

[1] *U. S. Naval Research Laboratory, Washington DC, USA*
[2] *Research Foundation for the State University of New York, SUNY Polytechnic Institute, Albany, New York USA*
[*] *todd.stievater@nrl.navy.mil*

Abstract: We report on a new the nitride-only photonic integrated circuit platform at AIM Photonics optimized for visible and near-infrared wavelengths (500 nm to 1000 nm). Waveguide propagation loss, passive component performance, and sensing are discussed.

AIM Photonics now offers a passive, low-loss photonic integrated circuit (PIC) platform based on silicon nitride (SiN) waveguide layers fabricated in a state-of-the-art 300-mm CMOS foundry [1, 2]. As shown in Fig. 1, the platform is currently offered with two vertically-separated SiN cores, the first nitride (FN) and the second nitride (SN) layers. A trench down to the FN waveguide layer is offered for sensing applications, and a dicing trench enables access to waveguide facets for low-loss edge coupling. This platform is available for multi-project-wafer (MPW) access between 700 nm and 1625 nm using a 220 nm thick FN waveguide layer with losses $<$ 0.1dB/cm at 1064 nm, 1310 nm, and 1560 nm. However, broadband operation of photonic integrated circuits at even shorter wavelengths is becoming increasingly important. Quantum information processing and quantum sensing [3] using trapped ions [4] or ultracold atoms [5] often uses electronic transitions in the visible (400 nm to 700 nm) or I-band (700 nm to 850 nm). Biological sensing with PICs uses fluorescent markers or target biomolecules with emission and absorption in the visible [6]. Detection of trace chemical vapors using waveguide-enhanced Raman spectroscopy (WERS) also benefits from shorter-wavelength laser sources to enhance the Stokes scattering cross-section [7].

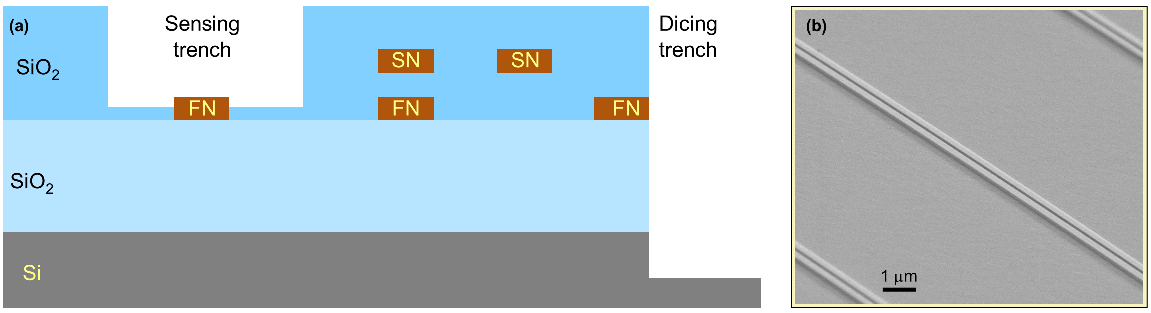

Fig. 1. **(a)**: AIM Photonics nitride-only platform. **(b)**: A scanning-electron microscope (SEM) image of nanoslot waveguides in a sensing trench

To extend low-loss operation of the AIM Photonics nitride-only platform to the visible, the FN layer is now offered with a thickness of 150 nm. This thickness, combined with sub-100 nm minimum feature size afforded by 193 nm immersion lithography, enables virtually any component to be fabricated for the visible. The wavelength range using this thinner FN layer can be extended to longer wavelengths such as the C-band using bilayer (FN and SN) waveguides.

The broadband measured losses are shown in Fig. 2 for the 150-nm-thick FN waveguides. Broadband waveguide measurements are performed using white-light spectroscopy [8, 9]. Unlike other low-loss nitride PIC platforms that achieve low-loss via weakly-confined ultrathin SiN cores ($\sim$ 20 nm or less) with bend radii $>$1 mm, these waveguides have low bend loss with bend radii of a few hundred μm to a few tens of μm, depending on the wavelength, waveguide width, and mode.

A process design kit (PDK) is under development to accompany this platform, similar to the TLX component library currently offered by AIM Photonics for the nitride-only platform with a 220 nm-thick FN layer. This new PDK includes broadband edge couplers, splitters, ring resonators, and directional couplers designed for both the TE$_{00}$ and TM$_{00}$ modes. Presently, components operate throughout one of three bands: Green/Yellow (G/Y,

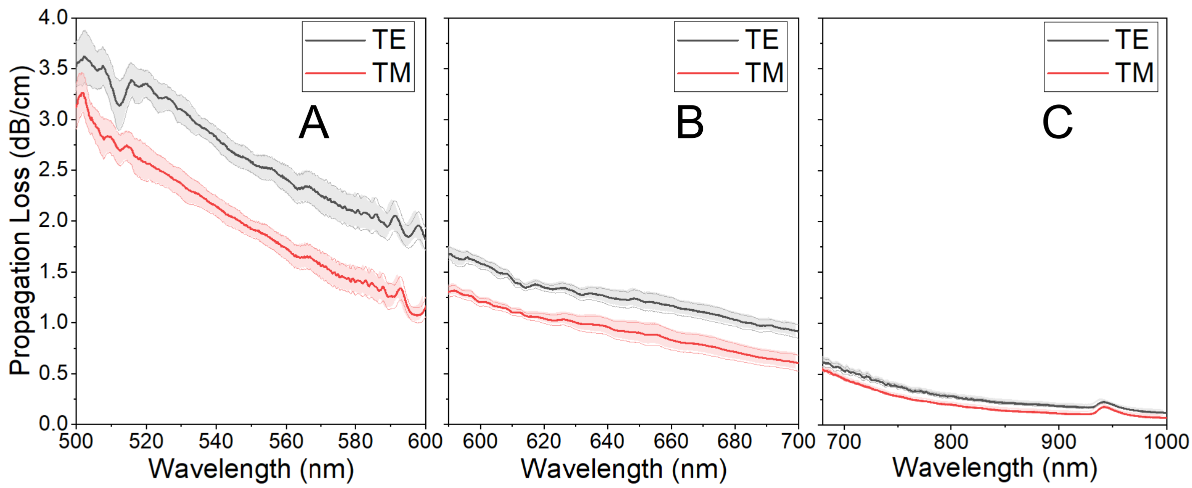

Fig. 2. Propagation loss vs. wavelength for the titride-only platform with 150 nm thick FN waveguides in the **(A)** G/Y-bands (400 nm wide); **(B)** the O/R-bands (500 nm wide); and **(C)** the I/Z-bands (800 nm wide). The shaded regions show the standard error of the measured loss.

500 nm to 600 nm); Orange/Red (O/R, 600 nm to 700 nm); or I/Z (700 nm to 1000 nm). This platform is also compatible with the Test, Assembly, and Packaging (TAP) capabilities of AIM Photonics. TAP provides low-loss fiber-attach, submounting, and system assembly for fabricated dice. This enables fully-packaged PICs to be efficiently integrated with custom fibers, sources, and detectors throughout the visible and near-infrared. We will present results from fiber-coupled sensing PICs assembled into packages designed for chemical vapor sensing via WERS.

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