Silicon Nitride for Integrated Photonic Applications

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Abstract-Due to its flexible optical properties silicon nitride is an attractive material for integrated photonic circuits. In this paper, we review the results we have obtained on near-infrared photonic devices including low loss waveguides based on SiN layers deposited with low temperature PECVD using an ammonia-free chemistry. In particular, we discuss the fabrication of subwavelength suspended structures to extend the use of SiN to mid-infrared photonic devices.

Silicon nitride (SiN) is a CMOS compatible material that provides a wide range of possibilities for integrated photonics due to its flexible material composition that can be tuned to achieve the physical, chemical and optical properties required for different applications. In particular, the refractive index of SiN can be easily tailored to achieve tight optical confinement for densely integrated structures with low sensitivity to surface and sidewall roughness [1, 2]. Also, SiN has a high non-linear Kerr coefficient, which makes it a viable material for non-linear applications especially because it does not suffer from two-photon absorption in the near-infrared wavelengths [3]. Furthermore, SiN has an improved transparency window at visible and mid-infrared wavelengths [4], which are important for biosensing applications.

Under this context, we have studied the deposition of SiN using plasma enhanced chemical vapour deposition with an ammonia-free chemistry to fabricate films with low hydrogen content for multilayer platforms at maximum substrate temperatures of 350ºC. We have also designed and demonstrated a variety of photonic devices including low loss waveguides, splitters and MMIs working in the near-infrared spectral region. Specially, we have studied the fabrication of subwalength suspended structures that can potentially be used to extend the results obtained with the near-infrared devices to the mid-infrared spectral region. The demonstrated suspended structures can be used to fabricate photonic devices for communications and sensing applications, using a similar approach to non-suspended structures that have already been demonstrated using SiN in the visible wavelength region.

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