Insertion Loss of Monolayer MoS_2 around C-Band Wavelengths on a Silicon Nitride Platform

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Integrated photonics is becoming increasingly crucial for emerging applications such as ultrahigh-speed communications, neuromorphic systems, and photonic computing. For these applications, low-powered, ultrahigh-speed integrated Pockels modulators present significant potential for efficient conversion between electronic and photonic signals[1]. The Pockels effect is a linear electro-optic effect that occurs exclusively in materials with 2nd-order nonlinear susceptibility (χ^2). The magnitude of this susceptibility directly correlates with the strength of the Pockels effect.

Recent studies have shown that monolayer molybdenum disulfide (1L MoS_2) possesses a χ^2 ranging from 0.1 to 100 pm/V[2,3]. These χ^2 values are greater than those of other atomically thin materials and even higher than those of most bulk materials, making 1L MoS_2 an ideal candidate for on-chip nonlinear devices with a small footprint and high efficiency. However, 1L MoS_2 must be sufficiently transparent for these applications to not affect device performance.

We report a low propagation insertion loss of < 2 dB/cm in on-chip monolithically integrated 1L MoS_2 on a Si_3N_4 photonic chip over the infrared telecom spectrum from 1520 nm to 1620 nm[4] (Fig. 1). We have applied a robust linear regression approach to highly sensitive resonances from racetrack resonators (RTRs) for insertion loss determination[5].

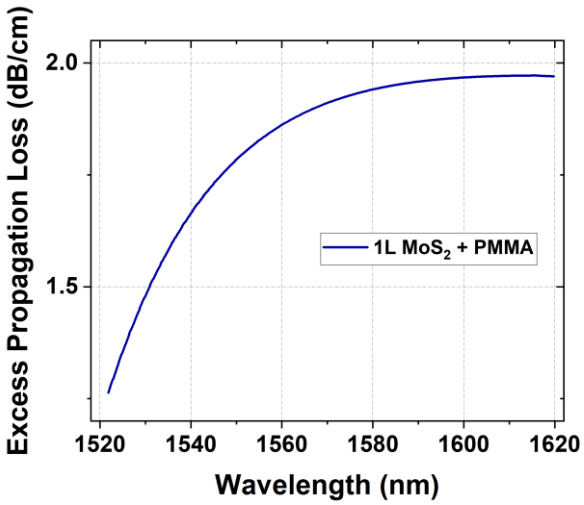

Figure 1. Propagation loss of 1L MoS_2 from 1520 nm to 1620 nm.

We also demonstrate that the traditional cutback method is unsuitable for analyzing such samples because of the randomness introduced by defects from the wet transfer process. Such defects still affect our reported loss of < 2 dB/cm and may dominate the loss attributed to 1L MoS_2. With further improvements in transfer processes or direct growth, 1L MoS_2 has the potential for remarkably low insertion losses suitable for developing compact linear and nonlinear devices such as Pockels modulators and transceivers for ultrahigh-speed optical communication and neuromorphic computing.

References:

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