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Self-Injection Locked Frequency Conversion Laser

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High-coherence visible and near-visible laser sources are centrally important to the operation of advanced position/navigation/timing systems as well as classical/quantum sensing systems. However, the complexity and size of these bench-top lasers are an impediment to their transition beyond the laboratory. Here, a system-on-chip that emits high-coherence near-visible lightwaves is demonstrated. The devices rely upon a new approach wherein wavelength conversion and coherence increase by self-injection locking are combined within a single nonlinear resonator. This simplified approach is demonstrated in a hybridly-integrated device and provides a short-term linewidth of around 4.7 kHz (10 kHz before filtering). On-chip converted optical power over 2 mW is also obtained. Moreover, measurements show that heterogeneous integration can result in a conversion efficiency higher than 25% with an output power over 11 mW. Because the approach uses mature III–V pump lasers in combination with thin-film lithium niobate, it can be scaled for low-cost manufacturing of high-coherence visible emitters. Also,

1. Introduction

Highly coherent semiconductor lasers are crucial for many applications, ranging from communication, spectroscopy, metrology, medicine, to quantum technology. Recent advances in integrated photonic lasers via hybrid/heterogeneous integration have shown remarkably narrow linewidths that are now comparable to or even surplus the bench-top solid-state counterparts.[1–4] So far, the majority of research efforts have focused on the telecom band around 1.2–1.7 μm, primarily in response to the significant demand from optical communication. Development is fairly limited in the visible and near-infrared spectral regions