Hybrid-integrated extended cavity mode-locked laser using SiN and a generic III/V platform

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Current fiber-based mode-locked lasers are already used in several applications, such as laser eye surgery and spectrograph calibration in the hunt for exoplanets. Miniaturizing and integrating such lasers can enable mass production which could result in new applications, for example distributed sensing of greenhouse gasses [1] and high-performance ranging [2]. Currently, the best performing integrated mode-locked lasers use an extended on-chip cavity. These have been shown on single chips in several III/V and heterogeneous platforms, by using active waveguides for gain, and passive waveguides for the low loss extended cavity [3,4]. In this work, these lasers are improved upon by butt-coupling an SiN extended cavity to the gain waveguides in a generic III/V platform, replacing the relatively lossy passive InP waveguides.

The SiN process used is based on 300 nm thick SiN that's patterned using e-beam lithography. Due to the low thickness, it was not possible to match both the height and the width of the mode to the standard outcoupler of the III/V chip. Therefore, edge couplers were made using the polymer SU8. This material can be spincoated, and waveguides can be defined using optical lithography. In this way, the mode width and height can be tuned independently, making it possible to couple efficiently to almost any waveguide. The coupling between the SiN waveguide and the SU8 waveguide was done by an inverse taper of the SiN under the SU8 waveguide. The SiN circuit uses a 3 cm SiN spiral and a 70% reflective sagnac output mirror. For the outcoupling another SU8 coupler is used, which is optimized for coupling to a lensed fiber.

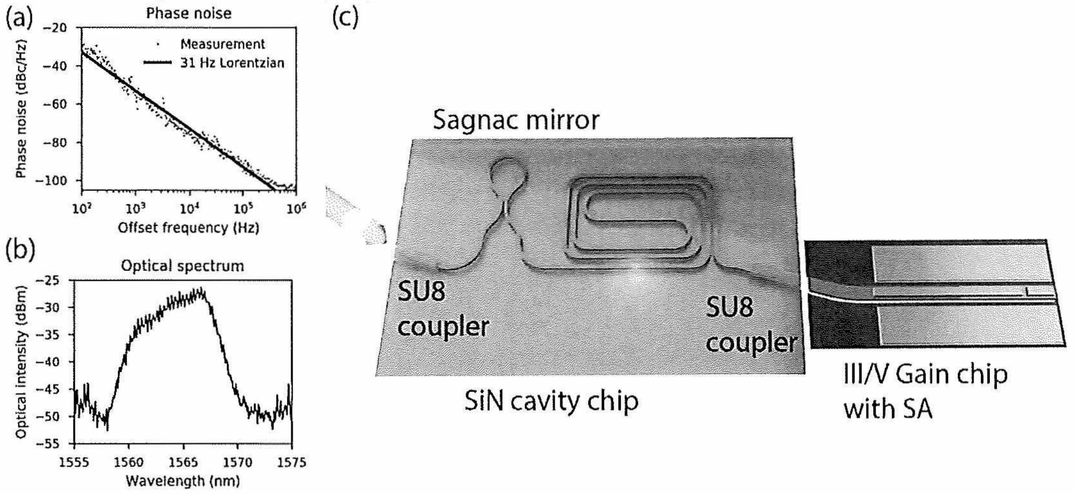

Fig. 1. (a): The measured phase noise of the 2.18 GHz fundamental beat note and the 31 Hz wide Lorentzian fit. (b): Optical spectrum of the laser. (c): artistic view of the mode locked laser, with the lensed fiber outcoupling on the left

Using this butt-coupling technique, a mode-locked laser was fabricated with a repetition rate of 2.18 GHz and a Lorentzian RF linewidth of 31 Hz, which is significantly lower than the linewidth achieved in monolithic III/V platforms. The laser's output power is limited to -5 dBm and the optical bandwidth of the comb is approximately 10 nm. The output power can be easily improved by changing the gain chip with one optimized for high power. Moreover, as the amplifier can remain on its native substrate, more efficient heat sinking can be used when compared to wafer-bonded III/V-on-silicon mode-locked lasers. As the passive cavity can be easily interchanged, filters and pulseshaping elements in the passive cavity can be tested for optimal performance [5].

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ROOM 1

61% is experimentally observed for far-field thermal diode made up of a VO2 film placed in vacuum and in front of a heat fluxmeter.

JSI-3.3 THU 9:00

Dynamically Tuned Infrared Emission using VO2 Thin Films.

•M.C. Larciprete[1], M. Centini[1], S. Paoloni[2], I. Fratoddi[3], S.A. Dereshgi[4], K. Tang[5], J. Wu[6], and K. Aydin[4]; [1]Dipartimento di Scienze di Base ed Applicate per l'Ingegneria, Sapienza Università di Roma, Italy, Roma, Italy; [2]Dipartimento di Ingegneria Industriale, Università degli Studi di Roma Tor Vergata, Roma, Italy; [3]Dipartimento di Chimica, Sapienza Università di Roma, Roma, Italy; [4]Department of Electrical and Computer Engineering, Northwestern University, Evanston (Illinois), USA; [5]Department of Materials Science and Engineering, University of California, Berkeley (California), USA; [6]Materials Sciences Division, Lawrence Berkeley National Laboratory, Berkeley (California), USA

We investigated the infrared emission of VO2 during phase transition and demonstrate that VO2 thin films are promising candidates for tuning and controlling the thermal radiation of an underlying hot body with different emissivity features.

JSI-3.4 THU 9:15

Highly efficient thermionic cooling nano-device: the quantum cascade cooler

•M. Bescond[1,2] and K. Hirakawa[1,2]; [1]LIMMS-CNRS, Tokyo, Japan; [2]Institute of Industrial Science and INQIE, University of Tokyo, Tokyo, Japan

ROOM 2

CG-5.2 THU 9:00

Observation of Rotational Doppler Shift for Harmonic Generation in Solids

•W. Komatsubara, K. Konishi, J. Yumoto, and M. Kuwata-Gonokami; The University of Tokyo, Tokyo, Japan

Spin angular momentum exchange of harmonic generation in solids can be observed by the Rotational Doppler Shift (RDS). Here, we generate harmonics from the crystal with no rotational symmetry and observe the two different RDS.

CG-5.3 THU 9:15

Rotational Quantum Beat Lasing without Inversion

•M. Richter[1], M. Lytova[2,3], F. Morales[1], S. Haessler[4], O. Smirnova[1], M. Spanner[2,3], and M. Ivanov[1]; [1]Max-Born-Institute, Berlin, Germany; [2]Department of Physics, University of Ottawa,

ROOM 3

CH-8.2 THU 9:00

Mid-infrared gas sensor based on hybrid graphene nanostructures and ultrathin gas-adsorbing polymer

•N.J. Bareza[1], B. Paulillo[1], K. Gopalan[1], R. Alani[1], and V. Pruneri[1,2]; [1]ICFO-Institut de Ciencies Fotoniques, The Barcelona Institute of Science and Technology, 08860 Castelldefels, Barcelona, Spain; [2]ICREA-Institució Catalana de Recerca i Estudis Avançats, Passeig Lluís Companys, 23, 08010 , Barcelona, Spain

Here, we present a novel gas sensing scheme in mid-infrared plasmonic detection based on a hybrid combination of graphene nanostructures and gas-adsorbing polymer. The plasmonic resonance is tuned with varying gas concentrations via reversible chemical doping of graphene.

CH-8.3 THU 9:15

Generating, probing and utilising photo-induced surface oxygen vacancies for trace molecular detection

•D. Glass[1,2], E. Cortes[1,3], R. Quesada-Cabrera[2], I.P. Parkin[2], and S.A. Maier[1,3]; [1]The Blackett Laboratory, Department of Physics,

ROOM 4

CB-6.2 THU 9:00

InGaAs Nano-ridge Laser Emitting in the Telecom O-band Monolithically Grown on a 300 mm Si Wafer

•D. Colucci[1,2], Y. Shi[1], M. Baryshnikova[2], Y. Mols[2], M. Muneeb[1], Y. De Koninck[2], M. Pantouvaki[2], J. Van Campenhout[2], B. Kunert[2], and D. Van Thourhout[1]; [1]Ghent University, Ghent, Belgium; [2]IMEC, Leuven , Belgium

Nano-ridge engineering is a novel approach for the monolithic integration of active components on the Silicon Photonics platform. By demonstrating lasing from a InGaAs nano-ridge we further extend its reach to telecom applications.

CB-6.3 THU 9:15

Hybrid-integrated extended cavity mode-locked laser using SiN and a generic III/V platform

•E. Vissers[1,2], S. Poelman[1,2], K. Van Gasse[1,2], and B. Kuyken[1,2]; [1]Photonics Research Group, Department of Information Technology, Ghent University IMEC, Ghent,

ROOM 5

CA-8.3 THU 9:00

Generation of a Radially Polarised Beam in a Solid-State Laser Using an Intracavity Spatially Variant Waveplate

T. Jefferson-Brain, Y. Lei, P. Kazansky, and •W. Clarkson; University of Southampton, Southampton, United Kingdom

Direct excitation of a radially polarized mode from an end-pumped Nd:YVO4 laser using an intracavity spatially variant waveplate is reported. The laser yielded a radially polarized output of 1.3W with a 35:1 polarization extinction ratio.

CA-8.4 THU 9:15

Geometrical Laguerre-Gaussian mode generation from an off-axis pumped Nd:GdVO4 degenerate laser

•Y. Ma[1], A.J. Lee[2], H.M. Pask[2], K. Miyamoto[1,3], and T. Omatsu[1,3]; [1]Chiba University, Chiba, Japan; [2]MQ Photonics Research Centre,

ROOM 6

CM-4.2 THU 9:00

Observation of Surface Plasmon Polaritons excited on Si Transiently Metalized with An Intense Femtosecond Laser pulse

•Y. Iida, M. Tateda, and G. Miyaji; Tokyo University of Agriculture and Technology, 2-24-16 Nakacho, Kognei, Tokyo 184-8588, Japan

We report on first observation of surface plasmon polaritons excited on Si transiently metalized with an intense femtosecond laser pulse. We found their characteristic properties can be controlled by a time delay of double pulses.

CM-4.3 THU 9:15

All Optical Holographic Encryption in Reduced Graphene Oxide Based on Laser Direct Writing

•Y. Dong, X. Fang, D. Lin, X. Ma, X. Chen, and M. Gu; Centre for Artificial-Intelligence Nanophotonics, School of Optical-Electrical

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