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

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The integration of III-V compound materials on Silicon is of paramount importance for the implementation of a complete Silicon Photonics platform where both active components, such as III-V laser diodes and amplifiers, and passive components are present. The monolithic growth of III-V materials on Si substrates is desirable in terms of cost efficiency, mass production and scalability. However, the large lattice mismatch between Si and most III-V compound materials of interest results in poor crystal quality for the deposited III-V film.

Nano-ridge engineering (NRE) is a new III-V integration approach which is based on selective area growth. The III-V growth is initiated inside narrow trenches patterned on (001) Si wafers to reduce the misfit defect density by aspect ratio trapping (ART). By controlling the growth conditions the volume out of the trench can be increased and the shape of the nano-ridges (NRs) engineered [1]. This NRE approach has already shown its potential through the successful demonstration of DFB lasers [2] and HBTs [3] based on GaAs nano-ridges but is also explored for other III-V material systems [4, 5]. Here, we further prove the power of our NRE technique by realizing a loss coupled DFB laser based on $In_{0.25}Ga_{0.75}As$ NRs which emit in the telecom O-band.

The common route to obtain an optical gain medium emitting at telecom wavelengths would be the growth of strained multi quantum wells (MQWs) on a InP substrate or InAs quantum dots on a GaAs substrate. However, by using NRE we are not limited to a binary alloy lattice constant. Fully relaxed $In_{0.25}Ga_{0.75}As$ NRs can be epitaxially grown on a 300 mm patterned Si substrate via MOVPE [5]. Then, to ensure light emitting in the O-band, a strained 3x InGaAs MQWs structure with 45% In is pseudomorphically grown on top of the NRs. A final $In_{0.72}Ga_{0.28}P$ capping layer lattice matched to $In_{0.25}Ga_{0.75}As$ guarantees the carrier confinement and reduces surface recombination, see Fig. 1 (a). The high crystal quality of this unique hetero-structure was confirmed by a TEM inspection. No misfit dislocations were visible in the NR volume on top of the pattern and very abrupt interfaces were realized as shown in Fig. 1 (b).

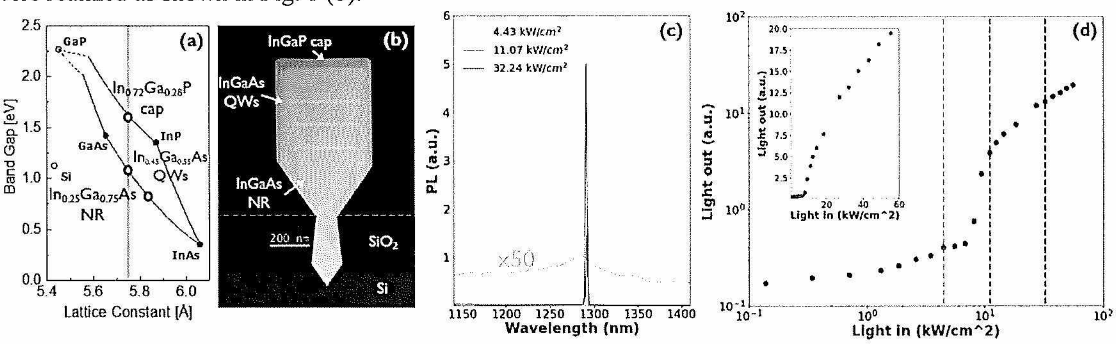

Fig. 1 (a) Bandgap energy (unstrained) vs. lattice constant, (b) Cross section of the InGaAs nano-ridge taken through HAADF STEM, (c) Spectra of the nano-ridge laser for different pump intensities, (d) light in-light out curve of the nano-ridge laser on logarithmic and linear (inset) scale with dashed lines referring to the pump intensities in the PL spectra.

A metal grating (5nm/40nm Ti/Au) with 205nm pitch and 37% duty cycle was patterned on top of the nano-ridge using a similar process as in [6]. The resulting loss-coupled DFB laser has then been measured on a micro photoluminescence set-up at room temperature under pulsed excitation. The spectra of the laser under increasing pump intensity are shown in Fig. 1 (c). From the light in-light out curve, shown in Fig. 1 (d), we derived a threshold of ~ 8 kW/cm^2, in line with the values obtained with the GaAs based nano-ridge lasers [2, 6]. These results emphasize again the potential of NRE to realize a monolithic integrated NR laser on Si emitting in the O-band and pave the way for future device application also in the telecom domain.

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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.

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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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