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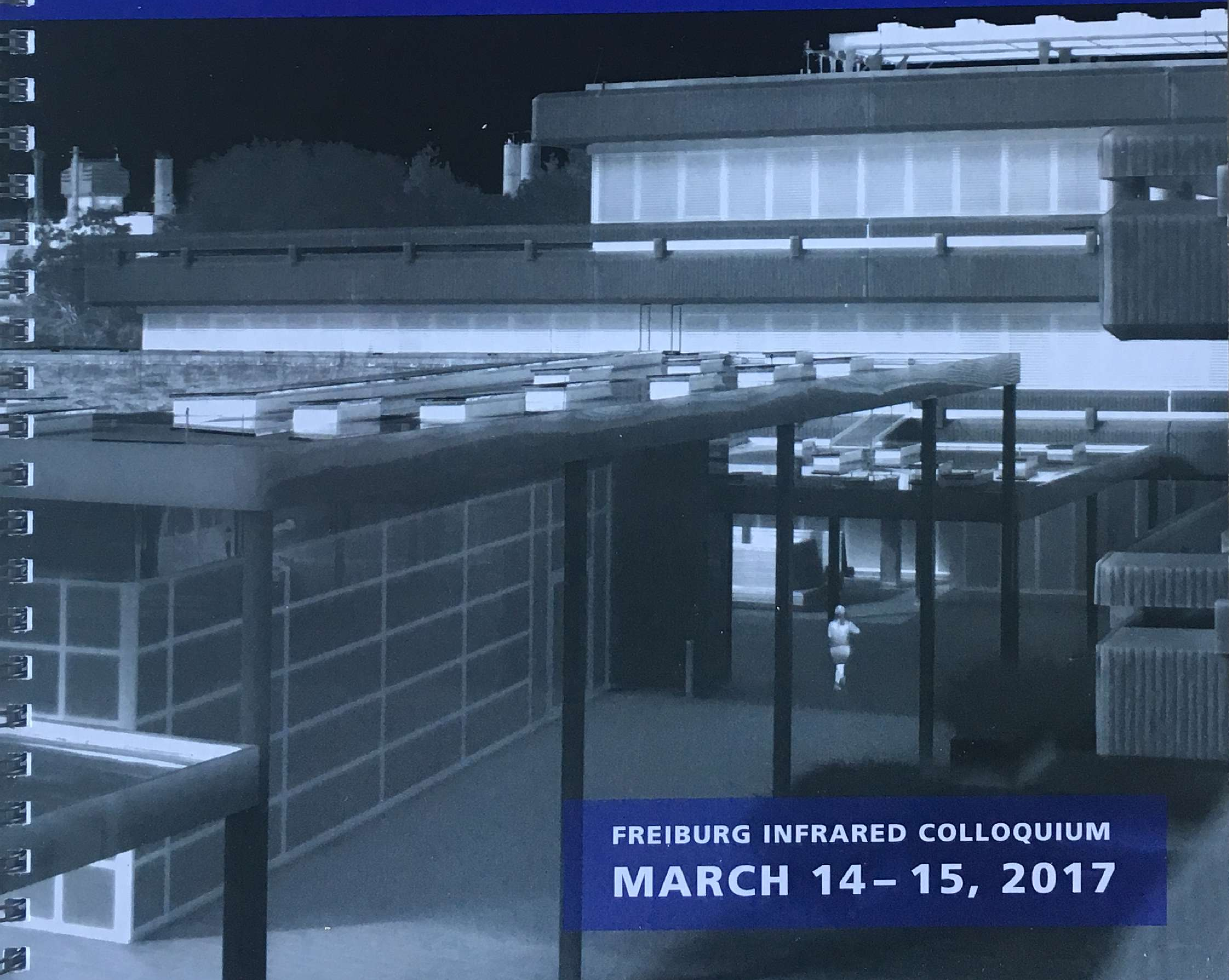
43RD FREIBURG INFRARED COLLOQUIUM
ABSTRACT BOOKLET



FREIBURG INFRARED COLLOQUIUM
MARCH 14– 15, 2017

GaSb LASERS

15:30 – 16:00 **4.1** **Invited Paper: High power GaSb lasers**
L. Shterengas, T. Hosoda, G. Kipshidze, T. Feng, M. Wang, and G. Belenky
Stony Brook University, Electrical and Computer Eng., Stony Brook, New York, USA

16:00 – 16:15 **4.2** **SDL and SDL-pumped Ho:YAG laser delivering high continuous-wave and high peak power in the 2 µm wavelength range**
M. Rattunde[1], P. Holl[1], S. Adler[1], K. Scholle[2], S. Lamrini[2], E. Diwo-Emmer[1], P. Fuhrberg[2], J. Wagner[1]
[1] Fraunhofer Institute for Applied Solid State Physics IAF, Freiburg, Germany
[2] LISA laser products OHG, Katlenburg-Lindau, Germany

16:15 – 16:30 **4.3** **Concepts for mid-infrared high-brightness GaSb diode-lasers**
L. Ogrodowski, S. Hilzensauer, J. Gilly, and M.T. Kelemen
Coherent | DILAS GmbH, Freiburg, Germany

16:30 – 16:45 **4.4** **Widely tunable GaSb-silicon hybrid lasers at 2 µm**
R. Wang[1,2], A. Malik[1,2], I. Šimonytė[3], A. Vizbaras[3], K. Vizbaras[3], and G. Roelkens[1,2]
[1] Photonics Research Group, Ghent University-imec, Belgium
[2] Center for Nano- and Biophotonics (NB-Photonics), Ghent University, Belgium
[3] Brolis Semiconductors UAB, Vilnius, Lithuania

16:45 – 17:00 **4.5** **GaSbBi alloys for mid-infrared optoelectronics**
O. Delorme[1,2], L. Cerutti[1,2], E. Tournié[1,2] and J.-B. Rodriguez[1,2]
[1] Univ. Montpellier, IES, UMR, France
[2] CNRS, IES, UMR, Montpellier, France

19:00 **Dinner**

Widely tunable GaSb-silicon hybrid lasers at 2 μm

Ruijun Wang*,[1,2], Aditya Malik[1,2], Ieva Šimonytė[3], Augustinas Vizbaras[3], Kristijonas Vizbaras [3], Gunther Roelkens[1,2]

[1]Photonics Research Group, Ghent University-imec, Technologiepark-Zwijnaarde 15 iGent, 9052 Ghent, Belgium
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Widely tunable semiconductor lasers operated in the 2 μm wavelength range attract strong interest for applications in optical spectroscopy. Distributed feedback (DFB) lasers and vertical cavity surface emitting lasers (VCSEL) are two types of classical semiconductor laser structures that can provide tunable laser emission by adjusting the laser injection current and the temperature of the heat sink. However, the achieved tuning range is quite limited. External cavity semiconductor lasers based on a Littrow configuration can provide much wider tuning, but bulky optical systems are required. In this study, we demonstrate a very compact widely tunable laser at 2 μm, using a silicon photonic integrated circuit (PIC) as the external feedback element.

The hybrid laser consists of a GaSb-based superluminescent diode (SLD) used as the gain chip and a silicon PIC used as the external feedback circuit, as schematically shown in Fig. 1(a). The light coupling between the gain chip and silicon PIC is realized by a silicon spot size converter (SSC). A Fabry-Perot laser cavity is formed between the HR-coated gain chip facet and a silicon waveguide DBR. The silicon photonics external cavity contains a Vernier filter consisting of two thermally tuned micro-ring resonators (MRRs) and a phase section to allow for quasi-continuous wavelength tuning. A Ti/Au micro-heater is integrated on the Vernier filter and phase section to thermally tune the lasing wavelength. A microscope image of the silicon Vernier filter is shown in Fig. 1(b).

Figure 2(a) shows the superimposed laser emission spectra by thermal tuning one MRR. A tuning range of 58 nm is obtained with a side mode suppression ratio better than 52 dB over the full tuning range and in the optimum operation point of more than 60 dB. When only one MRR is thermally tuned, the tuning resolution is determined by the free spectra range (FSR) of the other MRR. In order to realize a fine wavelength tuning, both MRRs should be simultaneously tuned. Figure 2(b) shows the superimposed spectra with 0.7 nm resolution tuning over 25 nm range by simultaneously adjusting two heaters. The resolution of tuning is still limited by the FSR of the longitudinal modes of the Fabry-Perot cavity when both heaters are tuned. A continuous tuning can be achieved by thermally tuning the phase shifter to continuously adjust the Fabry-Perot cavity length. A spectral map of the fiber-coupled laser emission as a function of the dissipated power in the heater of the phase section is shown in Fig. 2(c) illustrating the fine tuning. Figure 2(d) shows the light-current-voltage curves of the hybrid laser. The uncooled laser has a maximum output power of 3.8 mW and threshold current density of 1 kA/cm^2 (corresponding to 100 mA threshold current).

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Figures

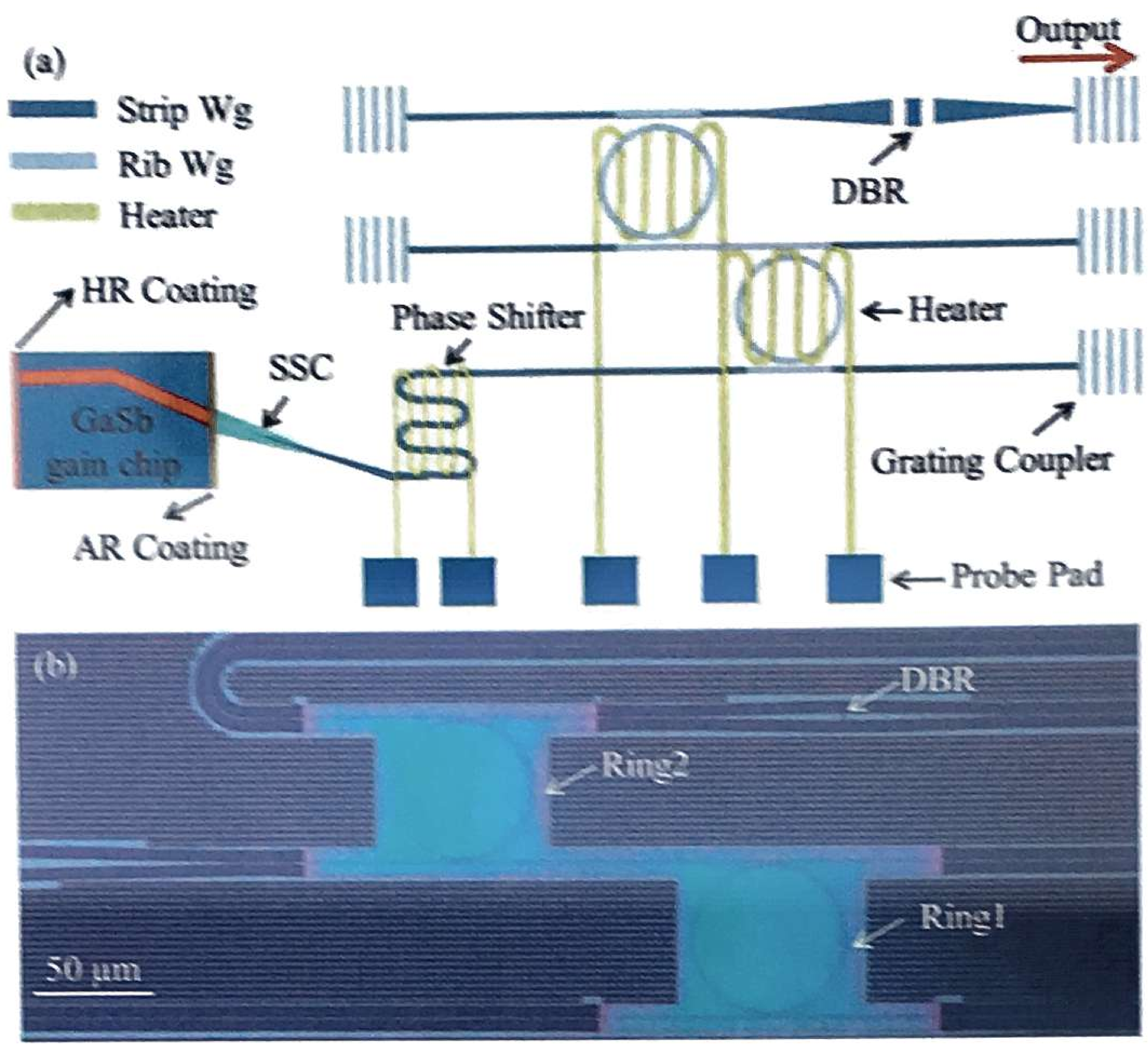

Fig. 1: (a) Schematic of a tunable GaSb-silicon hybrid laser using a silicon PIC as the feedback circuit; (b) microscope image of the silicon Vernier filter.

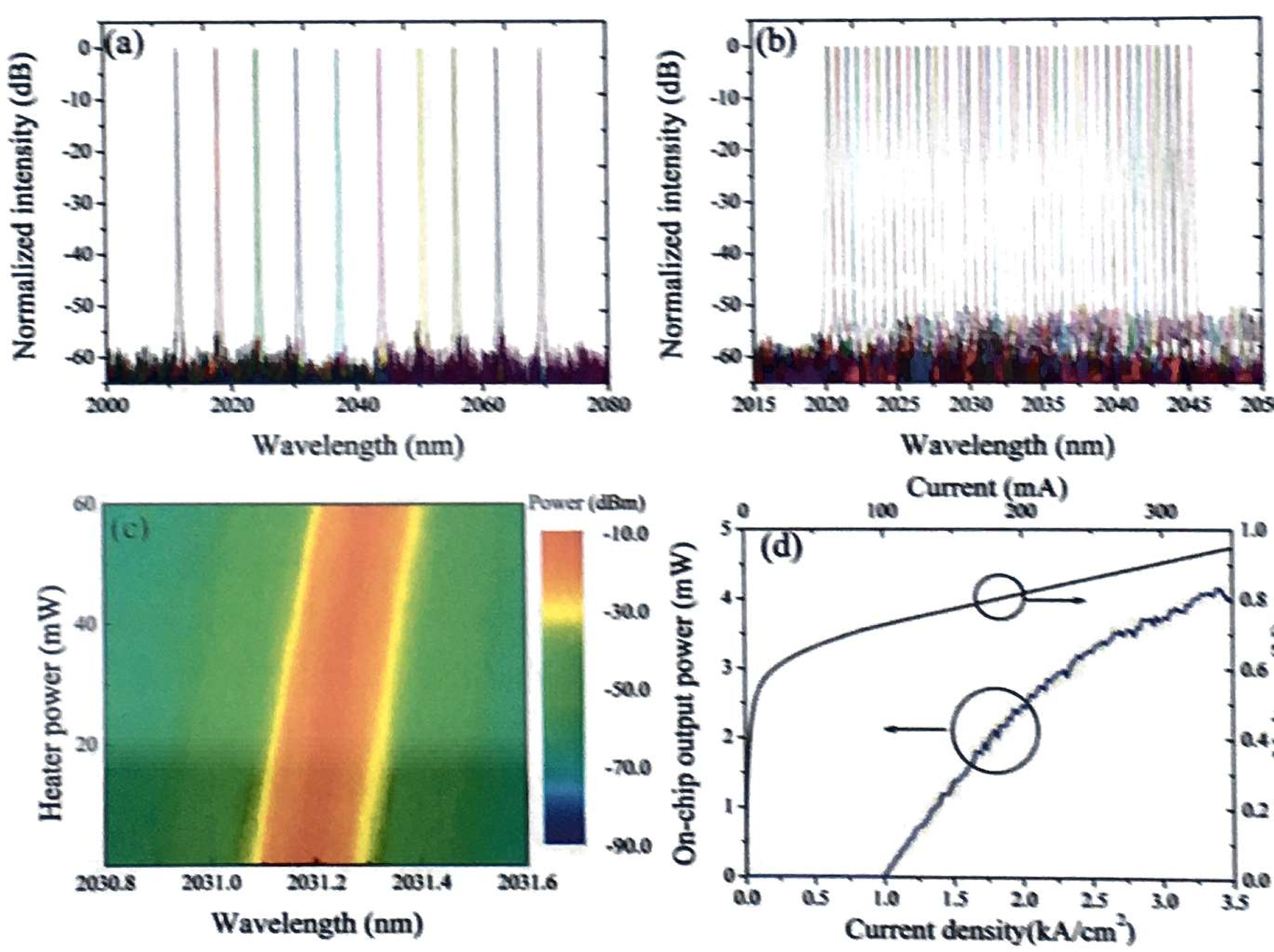

Fig. 2: Superimposed spectra of the hybrid laser by thermally tuning of only one MRR (a), both MRRs (b), phase shifter (c); (d) Light-current-voltage curves of the hybrid laser with a coupling gap of 500nm between the MRRs and bus waveguide.