Laser Science to Photonic Applications
(/)

**Technical Conference:**
15 – 20 May 2022
**Exhibition:**
17 – 19 May 2022

San Jose McEnery Convention Center
San Jose, California, USA

# It's a Wrap

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# Technology Showcase

**Technology Showcase: Why is Beam Profiling Difficult Compared to Other Laser Measurements and What Can You Do About It? Tips and Techniques (TS1)**

**Technology Showcase: What is Laser Trapping and Excitation and why is it Crucial for Quantum Computing? Developments in Laser Technology and Techniques (TS2)**

**Technology Showcase: MIRO Altitude - The state-of-the-art in laser beam measurement (TS3)**

**Technology Showcase: Photon Counting Technologies for Low Light Applications (TS4)**

**Technology Showcase: Laser and Optomechanics Developments From Thorlabs (TS5)**

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(UTC - 07:00)

Presentation Details

Paper (https://opg.optica.org/accountLogin.cfm?evt=1&evtname=CLEO&redirectURL=%2Fupcoming_conference_pdf%2Ecfm%3Fid%3D3752125

Add to Schedule (https://event.crowdcompass.com/cleo22/activity/0YTwqrmL7N)

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19:12 - 19:24
(UTC - 07:00)

*JTh6A.3*

**High Aspect Ratio and High-Speed Glass Drilling With Femtosecond GHz-Bursts**

*Presenter: Inka Manek-Hönninger, University of Bordeaux - CNRS - CEA CELIA UMR5107, France*

Presentation Details

Paper (https://opg.optica.org/accountLogin.cfm?evt=1&evtname=CLEO&redirectURL=%2Fupcoming_conference_pdf%2Ecfm%3Fid%3D3756616

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19:24 - 19:36
(UTC - 07:00)

*JTh6A.4*

**Direct Nanosecond Laser Welding of Semiconductor Materials**

*Presenter: David Grojo, CNRS / Aix-Marseille Univ., France*

Presentation Details

Paper (https://opg.optica.org/accountLogin.cfm?evt=1&evtname=CLEO&redirectURL=%2Fupcoming_conference_pdf%2Ecfm%3Fid%3D3756987

Add to Schedule (https://event.crowdcompass.com/cleo22/activity/BPKzukdi3f)

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19:36 - 19:48
(UTC - 07:00)

*JTh6A.5*

**Unipolar Quantum Technology Enabling High-Speed Free-Space Communication in the Long-Wa**

*Presenter: Pierre DIDIER, Telecom Paris, France*

Presentation Details

Paper (https://opg.optica.org/accountLogin.cfm?evt=1&evtname=CLEO&redirectURL=%2Fupcoming_conference_pdf%2Ecfm%3Fid%3D3745603

Add to Schedule (https://event.crowdcompass.com/cleo22/activity/3oXg4B64cO)

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19:48 - 20:00
(UTC - 07:00)

*JTh6A.6*

**Dual-Comb Biosensing for Rapid Detection of SARS-CoV-2**

*Presenter: Takeshi Yasui, Tokushima University, Japan*

Presentation Details

Paper (https://opg.optica.org/accountLogin.cfm?evt=1&evtname=CLEO&redirectURL=%2Fupcoming_conference_pdf%2Ecfm%3Fid%3D3756417

Add to Schedule (https://event.crowdcompass.com/cleo22/activity/PGhDYEh7DF)

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20:00 - 20:12
(UTC - 07:00)

*JTh6A.7*

**Implantable Neural Probe System for Patterned Photostimulation and Electrophysiology Recor**

*Presenter: Fu-Der Chen, Max Planck Institute for Microstructure Physics, Germany*

Presentation Details

Paper (https://opg.optica.org/accountLogin.cfm?evt=1&evtname=CLEO&redirectURL=%2Fupcoming_conference_pdf%2Ecfm%3Fid%3D3757262

Add to Schedule (https://event.crowdcompass.com/cleo22/activity/4jND9RQs12)

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20:12 - 20:24
(UTC - 07:00)

*JTh6A.8*

**Nonreciprocal Light-Driven Vortex Isolator**

*Presenter: Birgit Stiller, MPI for the science of light, Germany*

Presentation Details

Paper (https://opg.optica.org/accountLogin.cfm?evt=1&evtname=CLEO&redirectURL=%2Fupcoming_conference_pdf%2Ecfm%3Fid%3D3756976

Add to Schedule (https://event.crowdcompass.com/cleo22/activity/lQgbbVCzz1)

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20:24 - 20:36
(UTC - 07:00)

*JTh6A.9*

**Storage of 147 Temporal Modes of Telecom-Band Single Photon With Fiber-Pigtailed $Er^{3+}$: LiNbC**

*Presenter: Qiang Zhou, Institute of Fundamental and Frontier Sciences & School of Optoelectronic Science and Engineering, Univ*

Presentation Details

Paper (https://opg.optica.org/accountLogin.cfm?evt=1&evtname=CLEO&redirectURL=%2Fupcoming_conference_pdf%2Ecfm%3Fid%3D3757243

Add to Schedule (https://event.crowdcompass.com/cleo22/activity/tANuWW28Gn)

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*JTh6A.1*

**Real-Time Reaction Monitoring of Liquids Based on Monolithic mid-IR Sensors**

20:36 - 20:48
(UTC - 07:00)

*Presenter: Borislav Hinkov, TU Wien, Austria*

Presentation Details

Paper (https://opg.optica.org/accountLogin.cfm?evt=1&evtname=CLEO&redirectURL=%2Fupcoming_conference_pdf%2Ecfm%3Fid%3D3756398

Add to Schedule (https://event.crowdcompass.com/cleo22/activity/PohkDkvTMk)

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*JTh6B*

## *Joint Postdeadline Presentation Session II*

*Presider: Roberto Paiella, Boston University, United States*
*Executive Ballroom 210B*

Add to Schedule (https://event.crowdcompass.com/cleo22/activity/JBTJiRE1uJ)

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19:00 - 19:12
(UTC - 07:00)

*JTh6B.1*

**1 Pb/s Transmission in a 125µm Diameter 4-Core MCF**

*Presenter: Benjamin Puttnam, National Inst Info & Comm Tech (NICT), Japan*

Presentation Details

Paper (https://opg.optica.org/accountLogin.cfm?evt=1&evtname=CLEO&redirectURL=%2Fupcoming_conference_pdf%2Ecfm%3Fid%3D3757246

Add to Schedule (https://event.crowdcompass.com/cleo22/activity/ufTqx9UJqn)

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19:12 - 19:24
(UTC - 07:00)

*JTh6B.2*

**Time Programmable Frequency Comb**

*Presenter: Emily Caldwell, National Institute of Standards and Technology, United States*

Presentation Details

Paper (https://opg.optica.org/accountLogin.cfm?evt=1&evtname=CLEO&redirectURL=%2Fupcoming_conference_pdf%2Ecfm%3Fid%3D3757165

Add to Schedule (https://event.crowdcompass.com/cleo22/activity/97Q0gMK5aN)

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19:24 - 19:36
(UTC - 07:00)

*JTh6B.4*

**Experimental Demonstration of Efficient OPA via Simultaneous SHG**

*Presenter: Noah Flemens, Cornell University, United States*

Presentation Details

Paper (https://opg.optica.org/accountLogin.cfm?evt=1&evtname=CLEO&redirectURL=%2Fupcoming_conference_pdf%2Ecfm%3Fid%3D3757124

Add to Schedule (https://event.crowdcompass.com/cleo22/activity/yEMaX1UihE)

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19:36 - 19:48
(UTC - 07:00)

*JTh6B.5*

**Tunable Threshold in $VO_2$-Based Photonic Devices Enabled by Defect Engineering**

*Presenter: Chenghao Wan, University of Wisconsin - Madison, United States*

Presentation Details

Paper (https://opg.optica.org/accountLogin.cfm?evt=1&evtname=CLEO&redirectURL=%2Fupcoming_conference_pdf%2Ecfm%3Fid%3D3756219

Add to Schedule (https://event.crowdcompass.com/cleo22/activity/DMxYK0g9O3)

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19:48 - 20:00
(UTC - 07:00)

*JTh6B.6*

**Tunable mid-Infrared Frequency Combs From Nanophotonic Parametric Oscillators**

*Presenter: Arkadev Roy, California Institute of Technology, United States*

Presentation Details

Paper (https://opg.optica.org/accountLogin.cfm?evt=1&evtname=CLEO&redirectURL=%2Fupcoming_conference_pdf%2Ecfm%3Fid%3D3757184

Add to Schedule (https://event.crowdcompass.com/cleo22/activity/L0q4RF27Yw)

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20:00 - 20:12
(UTC - 07:00)

*JTh6B.7*

**On-Chip Electro-Optic Frequency Comb Generation Using a Heterogeneously Integrated Laser**

*Presenter: Isaac Luntadila Lufungula, Ghent University, Belgium*

# Real-time reaction monitoring of liquids based on monolithic mid-IR sensors

**Borislav Hinkov,[1,*] Florian Pilat,[1] Mauro David,[1] Georg Marschick,[1,*] Elena Arigliani,[1,*] Patricia L. Souza,[1,2] Andreas Schwaighofer,[3] Laurin Lux,[3] Bettina Baumgartner,[3,4] Daniela Ristanić,[1] Benedikt Schwarz,[1] Hermann Detz,[1,5] Aaron M. Andrews,[1] Bernhard Lendl,[3] and Gottfried Strasser,[1]**

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[3] *Institute of Chemical Technologies and Analytics, TU Wien, 1060 Vienna, Austria*
[4] *Debye Institute for Nanomaterials Science, Utrecht University, Utrecht, Netherlands*
[5] *CEITEC, Brno University of Technology, Brno, Czech Republic*

[*] *borislav.hinkov@tuwien.ac.at*

**Abstract:** We present a fingertip-sized mid-IR lab-on-a-chip for selective and sensitive time-resolved spectroscopy of liquids. Breakthrough beyond state-of-the-art operation of our monolithic sensor is demonstrated by real-time in-situ reaction-monitoring of conformational changes in a protein solution. 

## 1. Introduction

The mid-infrared (mid-IR) spectroscopy of molecules in liquid phase was long time limited to bulky detection systems like Fourier-Transform Interferometer (FTIR-)based sensors. They were often posing stringent limitations on sample preparation and demanding for time-consuming offline analytic. Nevertheless, the mid-IR is the ideal spectral range for selective and sensitive probing of molecules, by addressing their fundamental absorptions.
For this purpose, we present a novel monolithic high-performance mid-IR QC laser and detector (QCLD) device, enabling the next generation of liquid sensing. It is based on pioneering work in quantum cascade (QC) technology together with monolithic integration techniques exploiting novel mid-IR plasmonic concepts (Fig. 1(a)) [1–3]. The result is an ultra-compact fingertip-sized optical sensor, which is highly suitable for liquid sensing [4, 5]. In contrast to typical state-of-the-art systems, it allows real-time analysis of dynamical processes in liquids including inline and *in-situ* measurements. We demonstrate its breakthrough level of performance in analytical chemistry by extending previous results [4], through novel on-chip measurements of the time-dependent conformational changes of the model-protein bovine serum albumin (BSA, Fig. 1(b)) [5].

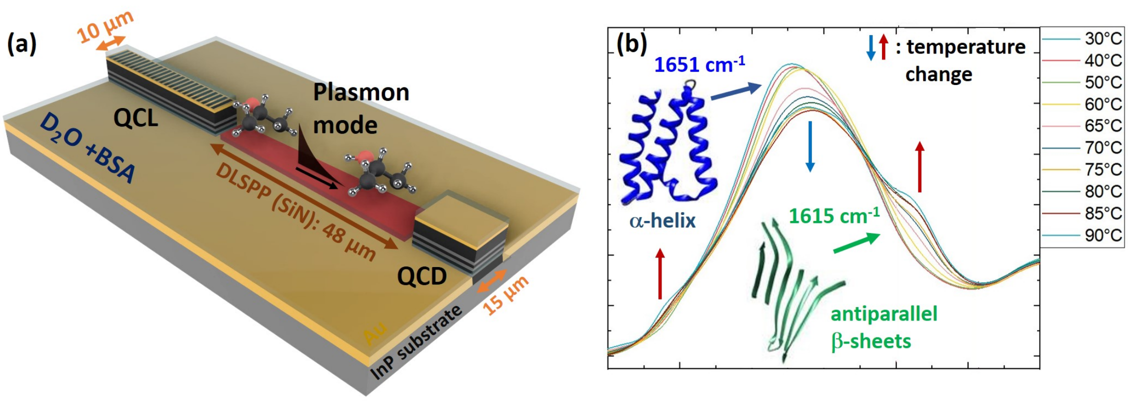


Fig. 1. (a) Sketch of the QCLD-based sensor including all relevant layers and dimensions labeled in the figure, when submerged in the protein solution (blue layer covering the whole chip) (b) Spectral changes of BSA when heated from 30°C to 90°C.

## 2. Experimental Results

The time-resolved measurement is conducted by combining our sensor with a custom-made 60-$\mu$l flow cell for inline measurements of the temperature-induced BSA conformational changes at 1620 cm$^{-1}$ (Fig. 1(b)). We use for all experiments a $D_2O$ matrix for reduced background absorption. For BSA an (irreversible) unfolding process from $\alpha$-helix to antiparallel $\beta$-sheet structure occurs when heating the solution from 20°C to 90°C, joined by shifting absorption bands in the molecule spectrum.

In our experiments we measure the typical protein denaturation curves, following a sigmoidal Boltzmann equation (*"S-shaped"*) with increasing temperature (Fig. 2)). In good agreement with literature, we observe a decreasing transition temperature with increasing BSA-concentration [6]. This is a significant step forward, since we are able to obtain those results in a much more compact and real-time configuration.

By additionally directly submerging the sensor into a beaker with the protein-analyte and monitoring its absorbance vs concentration curve (*calibration line*), we can extract the important figures-of-merit of our on-chip detector. A following comparison with a state-of-the-art attenuated total reflection (ATR-)FTIR reference system reveals the superior performance of our ultra-compact sensor by having: a 55-times higher absorbance value, a 120 times lower LOD ($LOD_{QCLD}$ ~75 ppm) and a coverage of more than three orders of magnitude of BSA concentrations from 0.0075 % to 9.23 %.

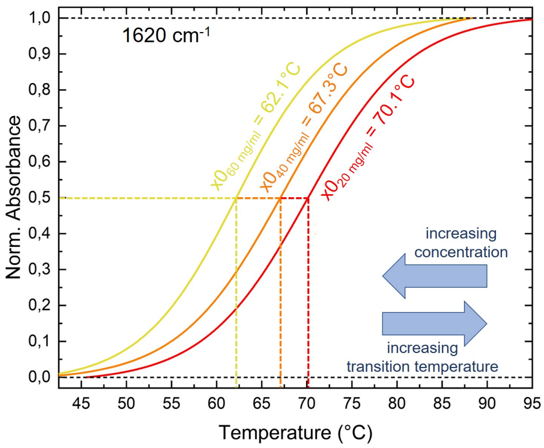


Fig. 2. Normalized concentration-dependent sigmoidal Boltzmann curves for increasing temperature, measured with our on-chip sensor at 1620 $cm^{-1}$. An increasing BSA-concentration in the liquid solution shows the typical decreasing transition temperature [6].

This work received funding from the EU Horizon 2020 Framework Program (project No. 828893). B.H. acknowledges funding by the Austrian Science Fund FWF through the Meitner program under M2485-N34.

## References

1. B. Schwarz, P. Reininger, D. Ristanić, H. Detz, A. M. Andrews, W. Schrenk and G. Strasser, "Monolithically integrated mid-infrared sensor using narrow mode operation and temperature feedback," Nat. Commun., **5**, 4085 (2014).
2. D. Ristanić, B. Schwarz, P. Reininger, H. Detz, T. Zederbauer, A. M. Andrews, W. Schrenk and G. Strasser, "Monolithically integrated mid-infrared lab-on-a-chip using plasmonics and quantum cascade structures," Appl. Phys. Lett., **106**, 041101 (2015).
3. M. David, A. Dabrowska, M. Sistani, I. C. Doganlar, E. Hinkelmann, H. Detz, W. M. Weber, B. Lendl, G. Strasser and B. Hinkov, "Octave-spanning low-loss mid-IR waveguides based on semiconductor-loaded plasmonics," Opt. Express, **29**, 26 (2021).
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5. B. Hinkov, F. Pilat, L. Lux, P. Lustoza Souza, M. David, A. Schwaighofer, D. Ristanić, B. Schwarz, H. Detz, A. M. Andrews, B. Lendl and G. Strasser, "A mid-infrared lab-on-a-chip for dynamic reaction monitoring," currently under review, 2022.
www.mt.com/dam/mt_ext_files/Editorial/LandingPage/8/DACH_PRO_Image/51725145a_v04_11gtpkftitrhbcomplet.pdf
6. A. Schwaighofer, M. R. Alcaráz, C. Araman, H. Goicoechea and B. Lendl, "External cavity quantum cascade laser infrared spectroscopy for secondary structure analysis of proteins at low concentrations," Sci. Rep., **6**, 33556 (2016).