

STUDY VISIT AND MATCHMAKING DIGITAL HEALTH

Intro

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DIGITAL HEALTH

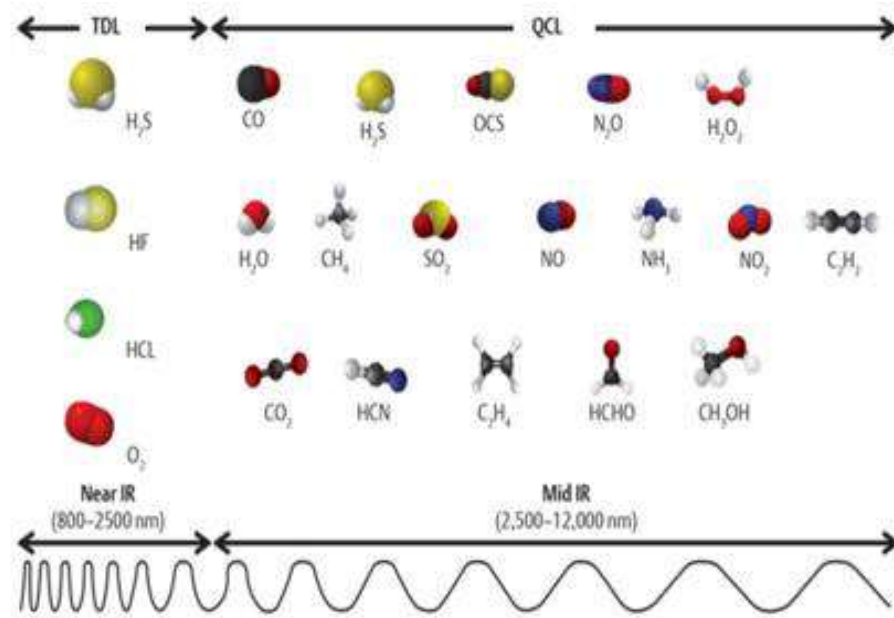
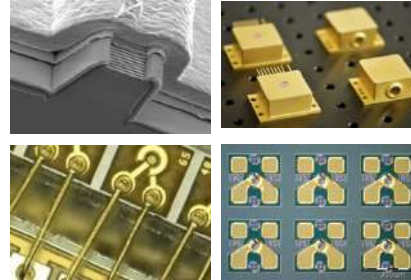
Łukasiewicz – IMiF: the Institute with experience in the field of optoelectronics fabrication and in the field of materials for photonics

Offered technologies:

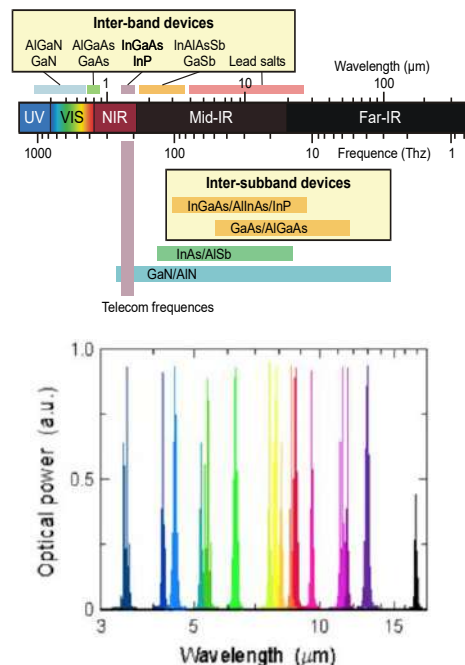
1) Infrared Emitters:

- QCL – emission in the MWIR range (4-5 μm)
- QCL – emission in the LWIR range (8-14 μm)

2) Integrated Infrared Photonics solutions



Spectral Range



Why Quantum Cascade Lasers in medical applications?

- **Broad Tunability:** QCLs can be tuned across a wide range of wavelengths, which corresponds to the vibrational absorption bands of many biological molecules. This makes them ideal for applications like spectroscopy and tissue imaging.
- **High Spectral Purity:** QCLs produce light with narrow linewidths and high spectral resolution, enabling precise identification of biomarkers or gases in medical diagnostics.
- **Mid-Infrared Emission:** The mid-infrared region (3–12 μm) in which QCLs operate is highly absorbed by biological tissues and molecules like proteins, lipids, and water. This makes them effective for applications such as imaging, spectroscopy, and targeted tissue therapy.
- **High Power Output:** QCLs deliver high output powers, making them suitable for medical applications that require high-intensity light sources, such as laser surgery or photothermal therapy.
- **Compact and Efficient Design:** QCLs are compact; small size and efficiency are beneficial for integrating into portable medical diagnostic equipment.
- **Non-invasive Capability:** ability to operate at specific wavelengths that penetrate tissues without causing harm makes QCLs highly suitable for non-invasive medical diagnostics, such as glucose monitoring or breath analysis.

Proposed cooperation on: Mid-IR lasers for medical applications

We propose the project targeting applications of Quantum Cascade Lasers (QCLs) in medical systems, e.g.:

1. **Medical Imaging:** QCLs are used in advanced imaging techniques, such as mid-infrared imaging, to provide high-resolution images of tissues. This helps in identifying abnormalities and diagnosing conditions like cancer at an early stage.
2. **Therapeutic Applications:** QCLs can be used for precision tissue ablation or modification in surgeries, especially in delicate areas like ophthalmology, due to their ability to target specific wavelengths that match tissue absorption properties.
3. **Spectroscopic Analysis:** In medical diagnostics, QCLs are employed in spectroscopy for detecting biomolecules in breath, blood, or tissue samples. This non-invasive method is valuable for disease detection and monitoring metabolic functions.
4. **Early Disease Detection:** QCLs enable the detection of trace gases and biomarkers, which are crucial for early diagnosis of diseases such as diabetes (through acetone detection) or respiratory conditions.
5. **Laser Surgery:** QCLs are being explored for use in laser-based surgeries where precise control of tissue removal or treatment is required. Their tunable wavelengths help in minimizing damage to surrounding tissues.
6. **Non-Invasive Glucose Monitoring:** QCLs can be used in the development of non-invasive glucose monitoring devices. By analyzing the absorption of specific wavelengths in the skin, glucose levels can be tracked without the need for blood samples.
7. **Photothermal Therapy:** QCLs are being investigated for use in photothermal therapies, where they can selectively heat and destroy cancerous cells without affecting surrounding healthy tissues.

Calls of interest

Key Opportunities:

HORIZON-CL4-2026-05-MATERIALS-PRODUCTION-01 New or enhanced Innovative Advanced Materials (IAM) enabled sensing functionality

- Focus:* Smart photonic materials and sensors
- Relevance:* Mid-IR PICs for medical sensing and diagnostics

HORIZON-CL4-2025-04-DIGITAL-EMERGING-01

- Photonics Partnership Call*
- Focus:* Multimodal sensor integration with photonics
- Relevance:* Mid-IR gas sensors (e.g. breath analysis), tissue spectroscopy

HORIZON-CL1-2026-2027 (Health technologies)

- Focus:* Next-gen diagnostic tools and digital medical technologies
- Relevance:* Integration of laser-based sensors for real-time, non-invasive diagnostics
- HORIZON-HLTH-2027-01-ENVHLTH-MISSCLIMA-03: Tools and technologies to support health adaptation to climate change
- HORIZON-HLTH-2027-02-DISEASE-01-two-stage: Innovative healthcare interventions for non-communicable diseases
- HORIZON-HLTH-2026-01-TOOL-03: Integrating New Approach Methodologies (NAMs) to advance biomedical research and regulatory testing

Proposed Use Cases for Mid-IR Quantum Cascade Lasers

Medical Applications:

- **Breath analysis**

- Detection of disease biomarkers (e.g. acetone, NO, VOCs) via laser-based IR gas spectroscopy

- **Tissue diagnostics & imaging**

- Mid-IR lasers integrated with Raman/SERS and optical biopsy tools for real-time cancer detection

- **Miniaturized endoscopic sensors**

- Mid-IR PICs for flexible medical probes in gastroenterology and pulmonology

- **Wearable gas sensors (“electronic noses”)**

- Medical IoT platforms using MIR-PICs for continuous health monitoring

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Research & Innovation Leaders

- **ICFO (Barcelona)** – Biophotonics, Raman/SERS, imaging & spectroscopy for healthcare
- **Universitat Politècnica de València** – Photonics & mid-IR sensing, integration with materials R&D
- **VLC Photonics / iPronics (Valencia)** – Advanced PIC design & mid-IR photonic integration



Clinical and Application Partners

- Spanish hospitals (Barcelona, Valencia) through ICFO clinical partnerships
- Bio/Medtech startups via Enterprise Europe Network (EEN)



Industrial Contributors

- **VIGO Photonics** (Poland, with links to Spain) – MIR photonic chips and detectors (HyperPIC project)
- **AI & software partners** – Data fusion, edge computing, real-time diagnostics

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Interest in cooperation – scientific and R&D:

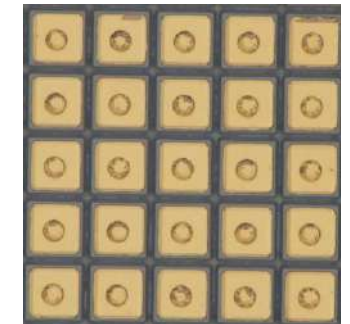
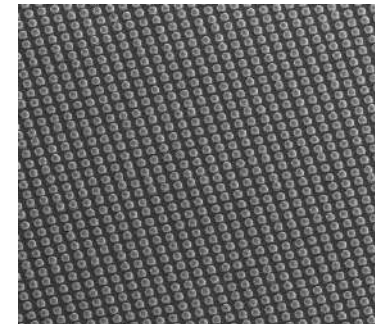
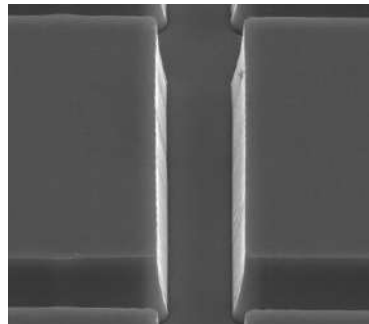
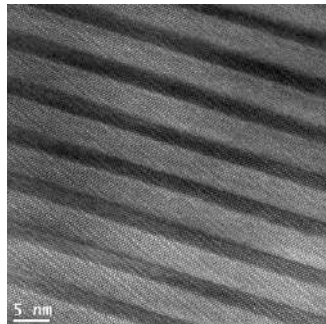
- Increase of know-how and technology level of the group, group development and strengthening
- Exchange of ideas and expanding collaboration with leading research groups
- Topics of cooperation:
 - Mid-IR devices and their applications, development of application specific light sources, lasers for sensing, IR-lasers for medical imaging,
 - ...

leading to joint projects (scientific or application-oriented) funded in the framework of Horizon Europe calls or other available funding schemes

R&D Experience:

We have realised many projects focused on development of devices up to TRL6 e.g.:

- Development of single mode QCLs for application in gas sensing systems
- Development of high power QCL (modules/heads) for military applications
- Development of QCL modules for mid-IR operating FSO system
- Development of MWIR heterostructures (growth and fabrication technology) and FPA processing



Thank you