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Ultra-compact, low-cost plasmo-photonic bimodal multiplexing sensor platforms as part of a holistic solution for food quality monitoring

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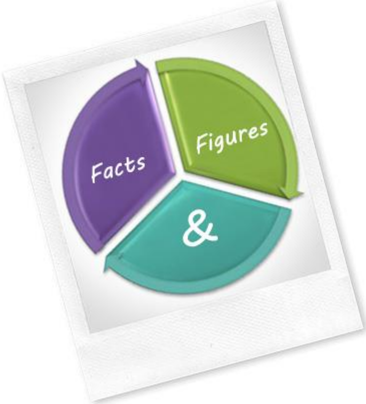
PHOTONICS21

Photonics Public Private Partnership

www.photonics21.org

Project Facts

Start date: 01/01/2021
Duration: 42 moths
Funding: ~€ 5,000,000
Partners: 14
Countries: 8



Project website: www.graced.tech

CyRIC, Consiglio Nazionale delle Ricerche, easy global market, bialoom, Multitel INNOVATION CENTRE, cnrs, sous les fraises FERMES URBAINES, ARISTOTLE UNIVERSITY OF THESSALONIKI, Pour une AGRICULTURE du VIVANT, AMO, Pilze Nagy A LASKAGOMBA-TERMESZTŐ, ISS BioSense innovation in optical biosensors, LUMENSIA sensors

Consortium

Project Coordinator

CyRIC

Multitel INNOVATION CENTRE

egm

System integration & cloud platform experts

IAMO

cnrs

ARISTOTLE UNIVERSITY OF THESSALONIKI

Institute of Food Sciences National Research Council of Italy

Academia and Research

TECNOALIMENTI

Pour une AGRICULTURE du VIVANT

sous les fraises PARIS

Pilze Nagy A LASKAGOMBA-TERMESZTŐ

Food industry representatives

bialoom

ISS BioSense Innovation in Optical Biosensors

LUMENSIA sensors

Photonic biosensors SMEs

Objectives

1. Develop a novel ultra-compact, cost-effective, plasmo-photonic bimodal sensor platform with on-chip light generation suitable for farm-to-fork applications (focus on F&V)

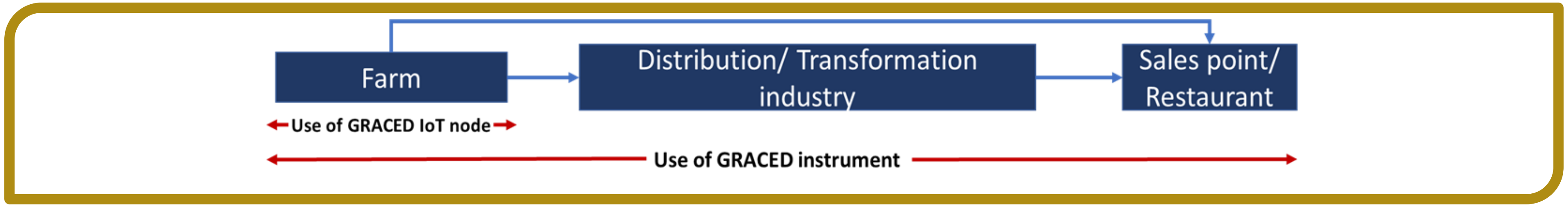
2. Develop the GRACED sensing devices to cover different application requirements (reusability, multi-modality, connectivity)

3. Develop the data analytics and sDSS platform to enable photonic-driven applications

4. Validate the complete approach and its impact through real-world pilots

5. Demonstrate the application-driven nature of the project and its impact in the EU farm-to-fork strategy implementation

The GRACED solution



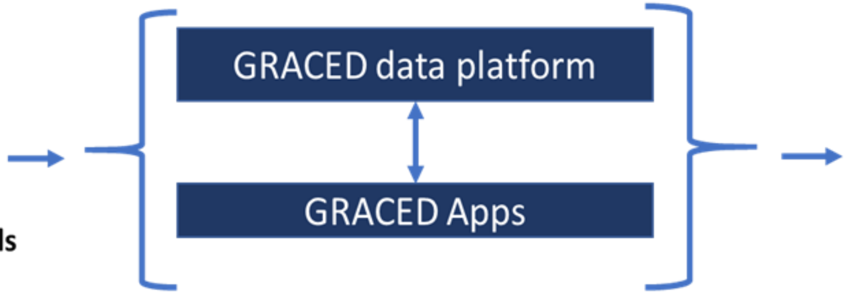
GRACED instrument

- 50x50x30 cm
- Analysis time: 20 min
- Production cost per (multi-parameter) sensor: 2-8€
- Suitable for all types of samples (liquid, solid)

GRACED IoT node

- 30x20x20 cm
- Analysis time: 25 min
- Production cost per (multi-parameter) sensor: 2-8€
- Suitable for liquid samples only
- Fully automated, on-line sensing (no human intervention for sampling)

Input from
- GRACED devices
- 3rd party data (i.e. meteo)
- Manual or ERP input on product/ production and additional controls



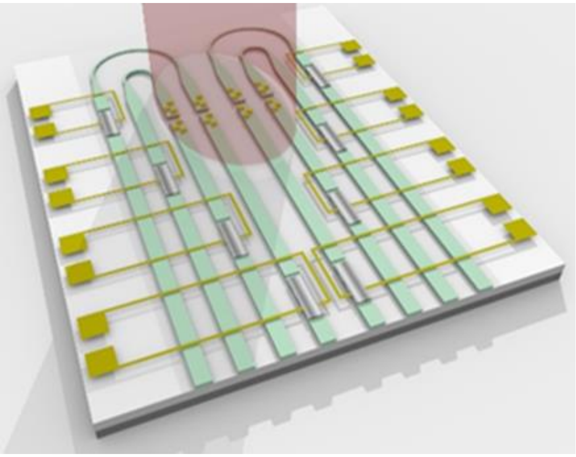
- Product lifetime quality monitoring Traceability
- Faster & more effective controls and support of EFSA assessments
- Support for automated product quality certification

The GRACED sensors

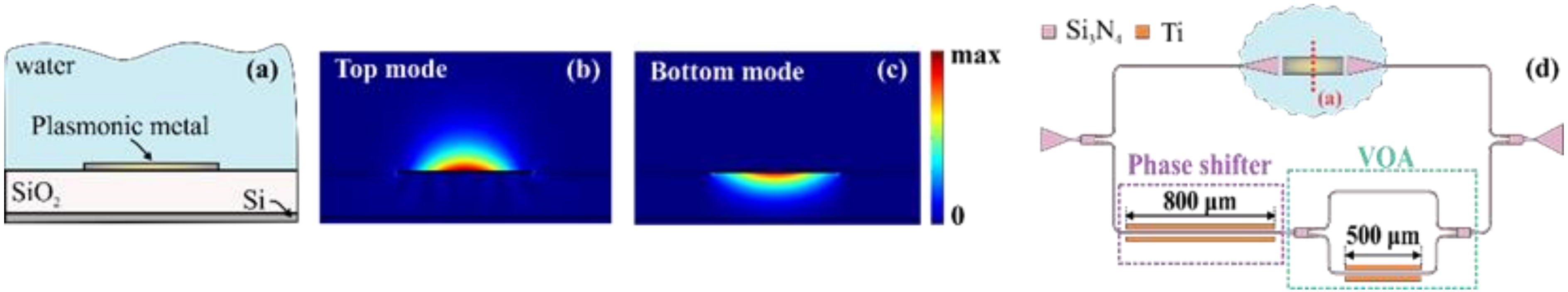
Cost-efficient, low-loss photonic integrated circuits (PIC), with graphene-augmented plasmonic bimodal interferometers to deliver ultra-small-form-factor biosensor arrays

The biosensors will be planarly illuminated by on-chip Colloidal Quantum Dot (CoQD) clusters avoiding complicated assembly with external optical sources or optical coupling schemes with stringent alignment requirements

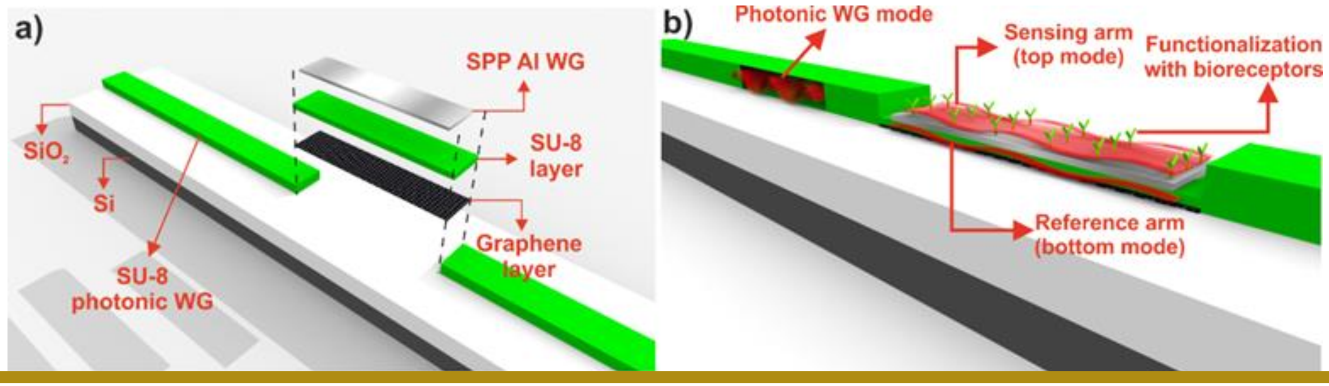
The sensors will be bio-functionalized against 7 contaminants of high importance to the pilot chains.



The GRACED sensors - history



Starting point: The sensor structures rely on a liquid-cladded plasmonic stripe waveguide (Figure a). Up to now such plasmonic waveguide was incorporated in the sensing arm of a SiN-based MZI (Figure d)



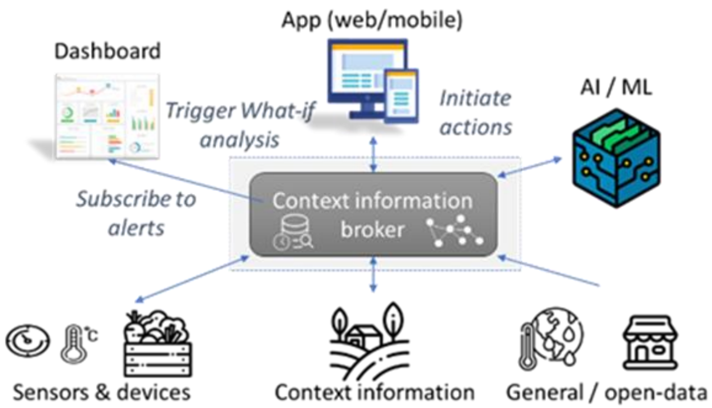
GRACED: Ultra-compact transducer length, use of graphene for power efficient control, identical temperature on top & bottom modes, cheap fabrication (SU8)

GRACED data analytics and sDSS

Implement a microservice architecture where a context information broker allows sharing of semantically enriched information across different services

The brokering function allows to connect data producer and data consumers together (respecting GDPR) whereas analytic functions such as complex event analysis and AI models are executed over the flow of data, generating new knowledge within the sDSS platform

Several smart services will provide descriptive, predictive, and prescriptive information to the users through **two applications**: an app with offline capabilities (running on a mobile phone/tablet), displaying measurement information and status (alert) report as well as a reconfigurable cloud application providing the advanced analytics and interaction capabilities with the stored datasets to provide different farm2fork oriented applications.



Expected Outcomes

- High density integration: Up to 100 sensors per chip
- Wafer – level fabrication: High - volume production
- Cost-effective kit simultaneously detecting:
  - ✓ Ochratoxin A:
  - ✓ Deoxynivalenol
  - ✓ Aflatoxin B2
  - ✓ E. coli O157
  - ✓ Salmonella
  - ✓ Imidacloprid
  - ✓ Acrylamide

<u>PROTOTYPE (1)</u> a portable instrument for laboratory & field analysis of all types of samples

<u>PROTOTYPE (2)</u> autonomous sensing node for unattended field measurements, particularly useful for production systems that foresee minimum human intervention (such as vertical/urban farming)

Pilot validation

- Real world, field pilots
- Four use cases covering different scenarios of:
  - food production by small/medium-sized farms
  - novel types of food production (urban farming and greywater reuse)
  - on-site food processing and vending (in-situ restaurants, on-site vending)
- Improve food yield, food quality & safety. Reduce food waste
- Sustainable, eco-friendly production and safe consumption of food for farmers and consumers

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For more information:

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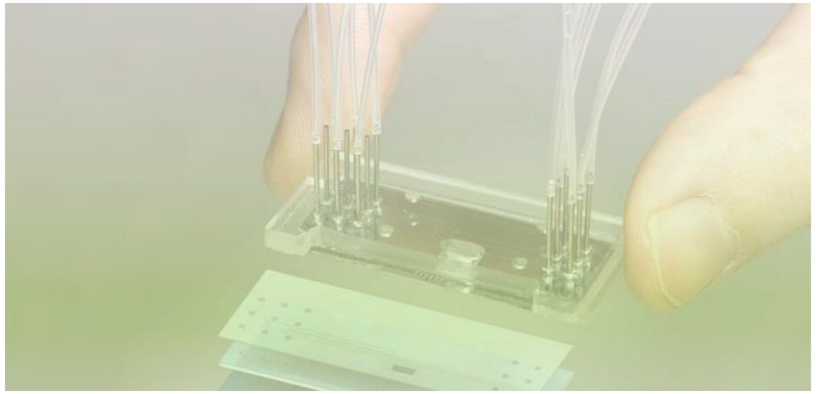

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