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The GRACED device

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SMART FARMING CONFERENCE

The GRACED device: leveraging *photonic* and *plasmonic* technology

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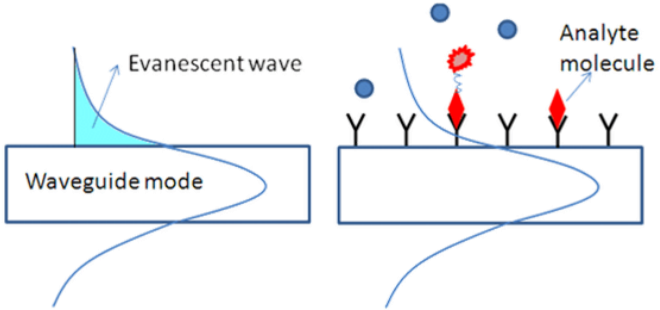
➢ ***Evanescent wave sensing***

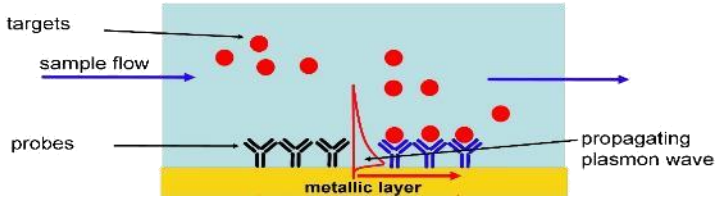
Analyte → Δn of external medium → Mode Δn_{eff} → Phase change, $\Delta\varphi = \frac{2\pi\Delta n_{eff}}{\lambda} L$ → Incorporation in a circuit, ΔI or $\Delta\lambda$

- ***Photonic***



✓ **Mode partially exposed to environment**

- ***Plasmonic***



A. Duval et al. (2007, SPIE Newsroom).

✓ **SPP mode *fully exposed* to overlying medium**

❖ **Enhanced sensitivity compared to evanescent wave photonic sensors !**

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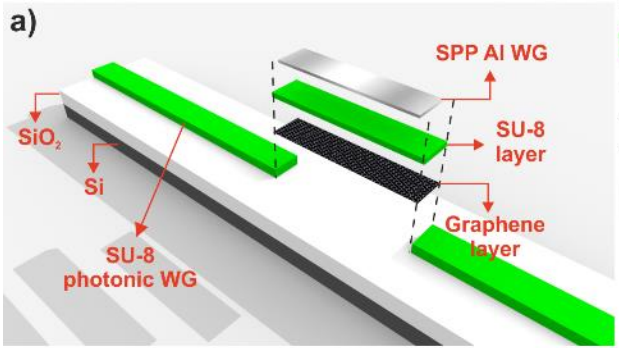
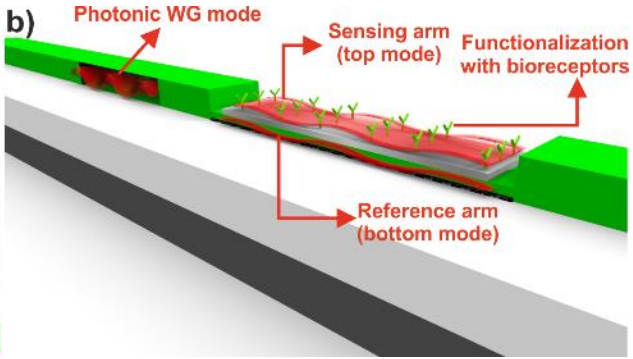
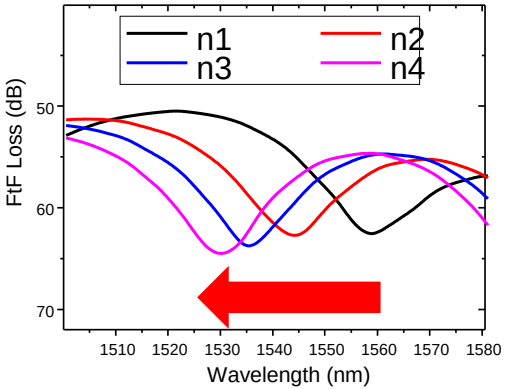
The technology: *Bi-modal* configuration on SU8 platform







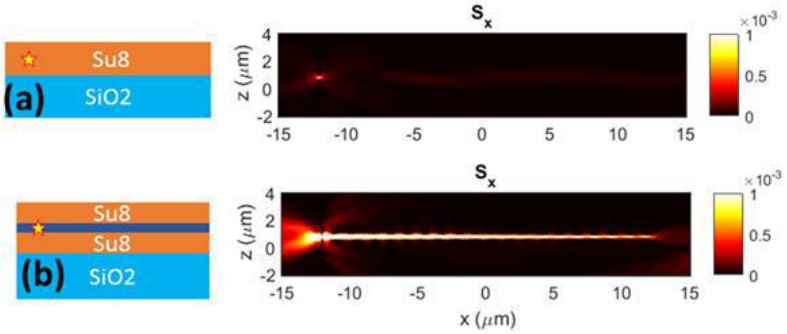
- **Interference between the 2 supported plasmonic modes**
- **Single arm Mach Zehnder**

Functionality of graphene

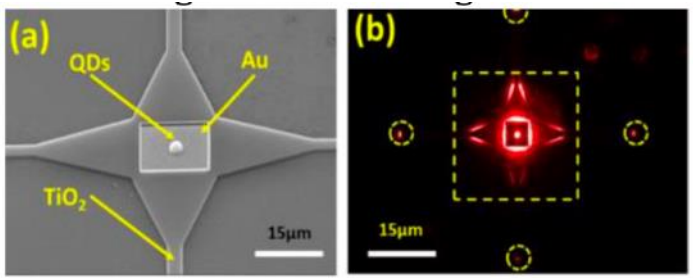
- The graphene layer will offer active control and perform as a variable optical attenuator by electrically tuning the propagation length of the bottom plasmonic mode, balancing losses of the 2 modes
- Improvement of extinction ratio (ER) at the output and enhance resolution

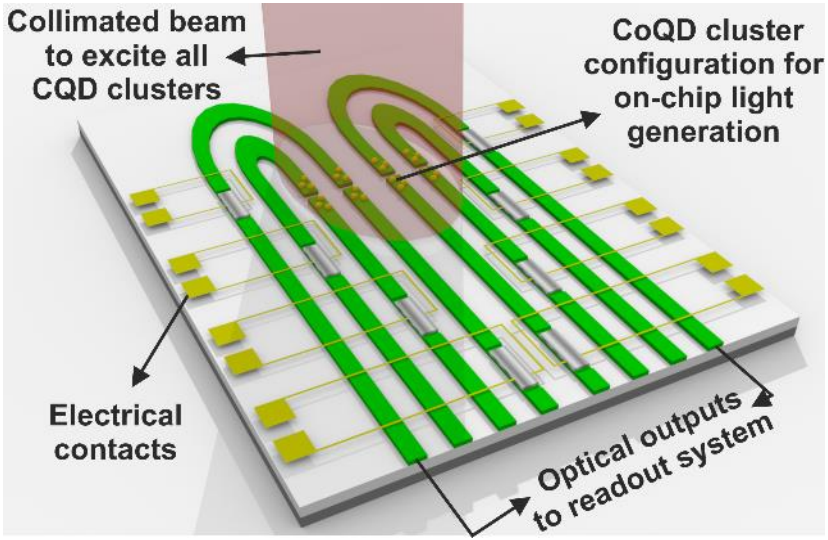
Alignment-free, on-chip light sources

❖ Development of CoQDs structures



- High index (n=3.5+i0.01) core waveguides for harvesting QDs fluorescence emission.





MREs and sensor surface functionalization

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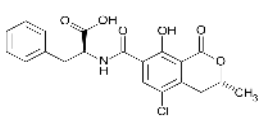
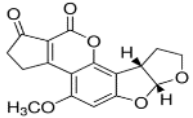
- Antibodies (polyclonal and monoclonal) will be used as molecular recognition elements (MREs) for the selected microbiological and chemical contaminants

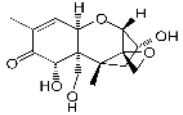
Target contaminants



1. Ochratoxin A

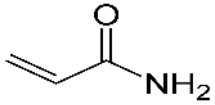


2. Aflatoxin B2

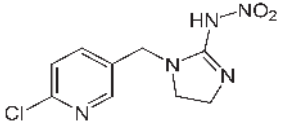


3. Deoxynivalenol

5/6. E. Coli/ salmonella



4. Acrylamide



7. Imidacloprid

LUMENSIA sensors

Institute of Food Sciences
National Research Council of Italy

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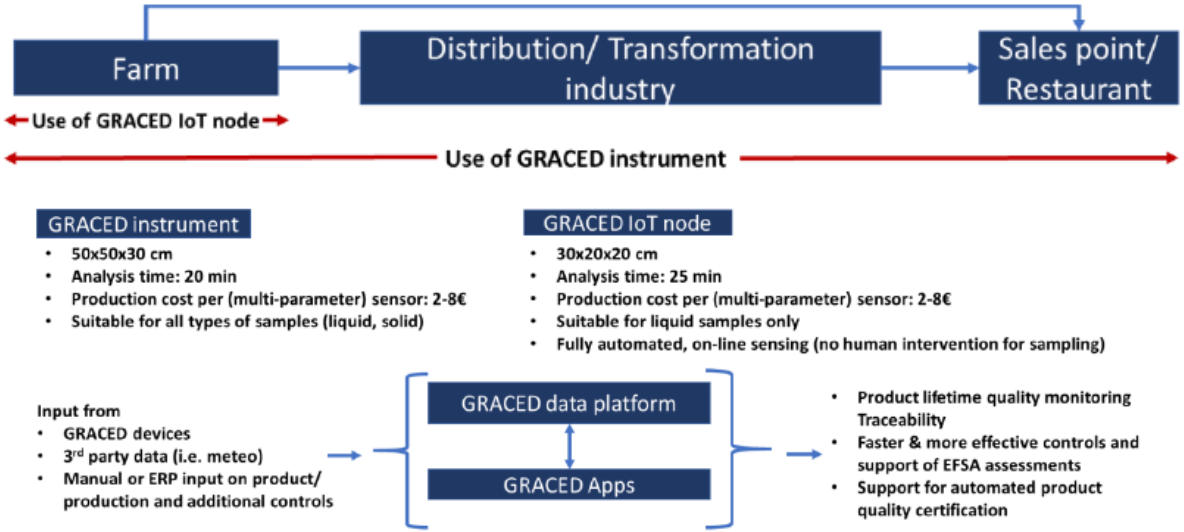
Final devices

1. **GRACED instrument:** a portable instrument for lab & field analysis of all types of samples
2. **GRACED IoT node:** an autonomous sensing node to be deployed for unattended field measurements in water/liquid samples only, particularly useful for production systems that foresee minimum human intervention (such as vertical/urban farming). This second device will include automated sampling & biosensors regeneration (at least 10 times).



Benefits

- ***Compact*** bimodal plasmo-photonic sensor
- ***Label-free*** detection
- Real-time and ***fast*** operation: 20-25min
- ***High bulk sensitivity***: > 25000 nm/RIU
- ***High-sensitivity*** *(target 95%)* and ***high-specificity*** *(target 90%)*
- ***Low-cost***
- ***Multiplexing*** capabilities: 7 analytes

THANK YOU!