CENTRE FOR ADVANCED PHOTONICS & PROCESS ANALYSIS

CAPPA

Innovation Through Light

Your Research Partner for Photonics Solutions

Pharmaceuticals · *Food Technology* · *Medical Devices* · *Sensors & Systems*

CAPPA EPIC Norway
April 2024

MTU
Ollscoil Teicneolaíochta na Mumhan
Munster Technological University

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CAPPA – A Research Centre of Munster Technological University

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49 PEOPLE
21 RESEARCHERS
28 POSTGRADUATES

23 PROJECTS
GREATER THAN €100K
CURRENTLY ACTIVE

79 PAPERS
PUBLISHED IN PEER-REVIEWED
JOURNALS IN LAST 5 YEARS

€16 MILLION
FUNDING AWARDED
IN LAST 5 YEARS

ENGAGED WITH
>220 COMPANIES
IRISH AND INTERNATIONAL
IN THE LAST 5 YEARS

COLLABORATING WITH
11 OF THE TOP **100**
UNIVERSITIES WORLDWIDE

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Centre For Advanced Photonics & Process Analysis CAPPA

- Technology Gateway based in MTU Cork
- Specialise in Optics and Photonics applications
- Cross disciplinary applications across all TRL levels
- Engagements: micro – MNA
  ½ day - multi annual
- Support for writing proposals and exploring funding options

Imaging & Microscopy
Element/ingredient mapping
Medical imaging
Defect analysis

Spectroscopy
Contaminant identification
Cancer screening
Chemometrics

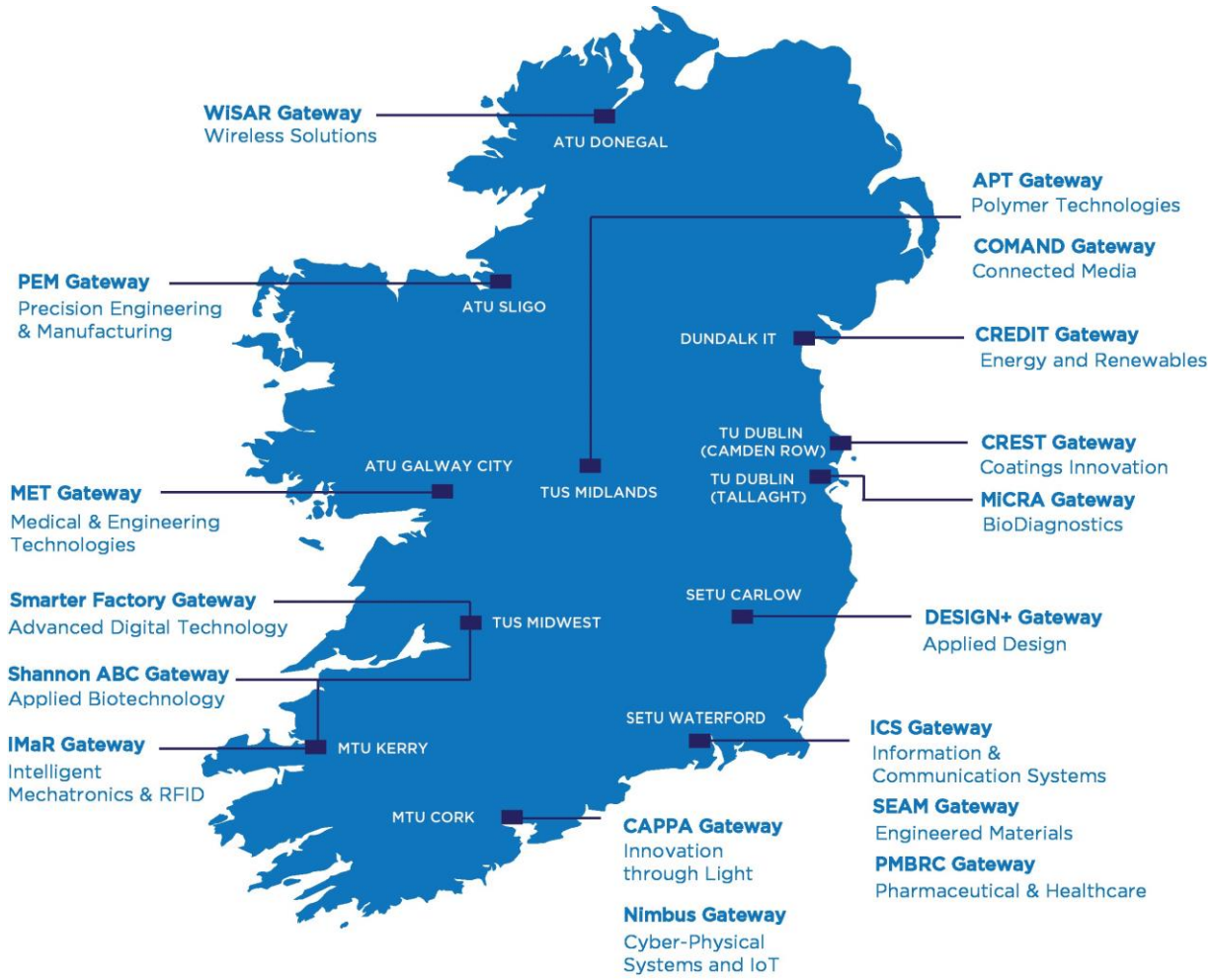
Sensing & Detection
Environmental monitoring
Water & soil analysis
Autonomous cars

Process Monitoring
In-line/on-line sensing
Machine vision
Process analysis & control

Nanophotonics
Photonic crystals
Hybrid lasers
Photonic Integrated Circuits

- *The Enterprise Ireland Technology Gateway Programme is co-financed by the Government of Ireland and the European Union through the ERDF Southern, Eastern & Midland Regional Programme 2021-27 and the Northern & Western Regional Programme 2021-27.*

Technology Gateway: Working With Industry



- 17 Gateways
- Funded By Enterprise Ireland
- Deliver R & D Solutions to Industry
- ~ 7,500 completed projects with Irish companies
- Food, Pharma, Design, Process Control, Process monitoring, material testing

- https://www.technologygateway.ie/

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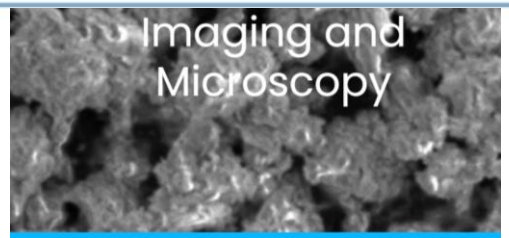
Rialtas na hÉireann Government of Ireland
Arna chomhchistiú ag an Aontas Eorpach Co-funded by the European Union
Tionól Réigiúnach an Deiscirt Southern Regional Assembly
Enterprise Ireland

The CAPPA Technology Gateway is co-financed by the Government of Ireland and the European Union through the ERDF Southern, Eastern & Midland Regional Programme 2021-27

Core Competencies

- Fluorescence Detection
- Time – Dependent Change Analysis
- Structural Changes in Materials
- Raw Ingredient Characterization
- Failure Mechanism Exploration
- Polymer Analysis
- Hyperspectral Imaging

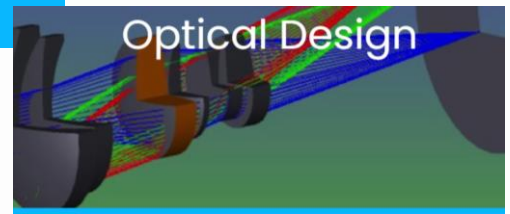


- Inspection
- Scanning Electron Microscopy
- Energy Dispersive Spectroscopy
- Polarized Light Imaging
- Defect Analysis
- Contamination Identification
- Raman Imaging

- Fibre – Based Sensing
- Trace Gas Sensing
- Sensors for Machine Vision and Inspection
- Sensors for Biomedical Applications
- Optical Sensing
- Detection of Concentrations
- Environmental Monitoring

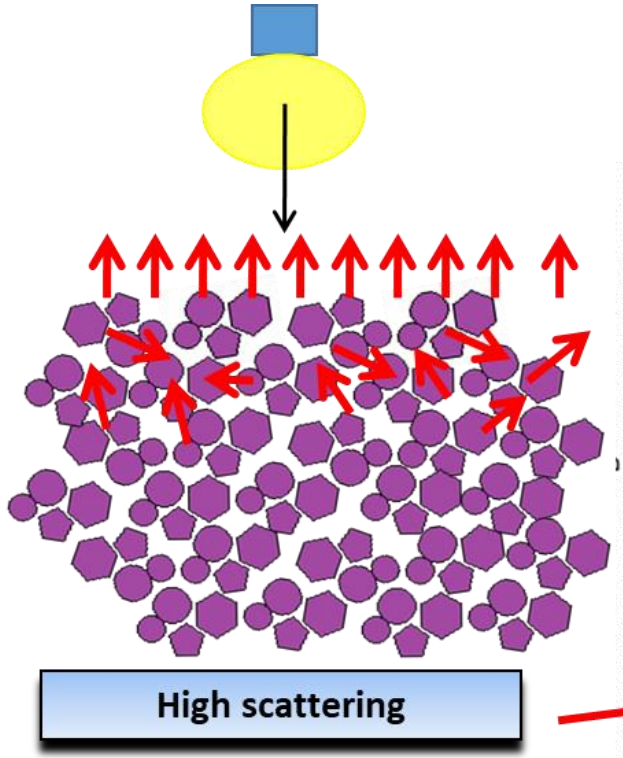
- In – line monitoring of moisture levels
- In – line monitoring of blend uniformity
- Online monitoring of rinse samples for cleaning verification
- Development of process automation to remove manual inspection
- Ingredient tracking in production processes

- Contamination Analysis
- Industrial Process Analysis
- Optimisation
- Principal Component Analysis
- Multivariate Curve Resolution



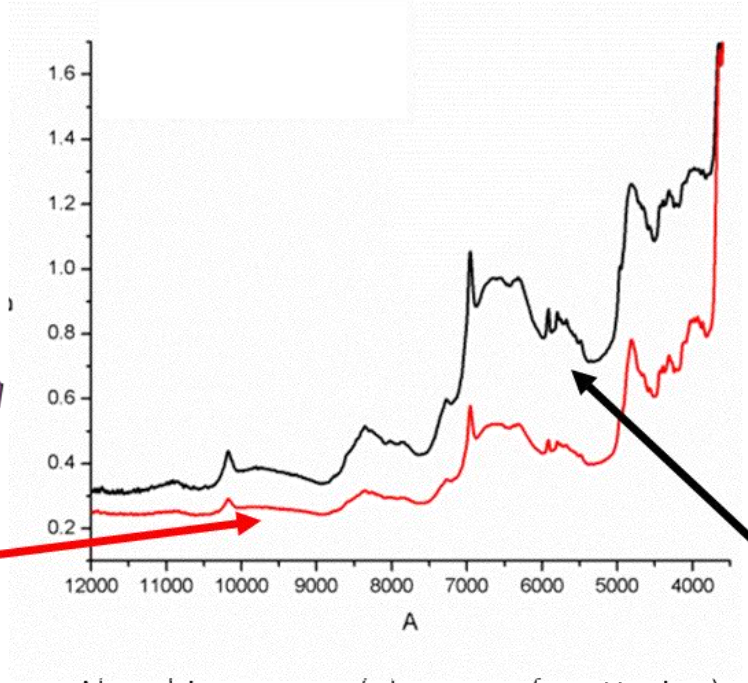
- Lens Design
- Imaging and Detection System design
- Laser optics
- Optical fibre systems
- Physical Phenomena modelling

Example of Particle Size and Scattering



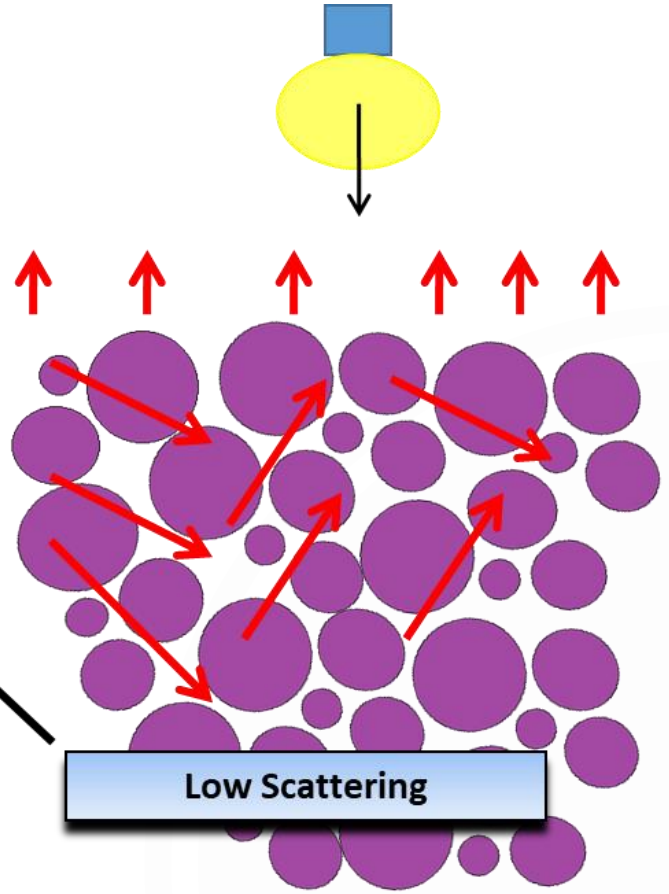
High scattering

Smaller particle sizes



Absorbing power (absence of scattering)

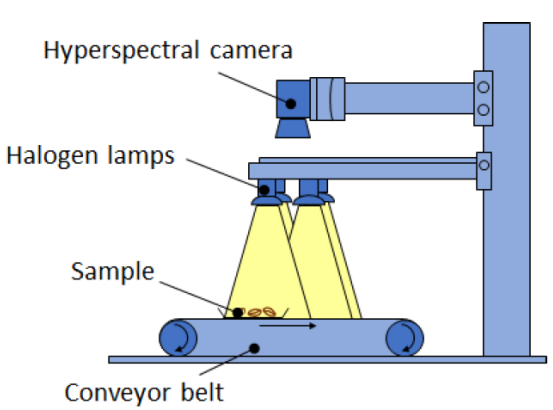
Absorption coefficient (includes effects of voids, surface reflection, distance traveled)

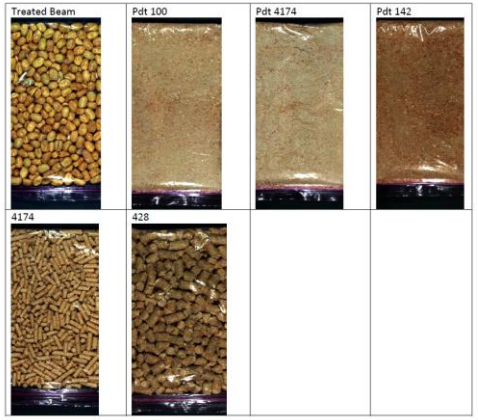


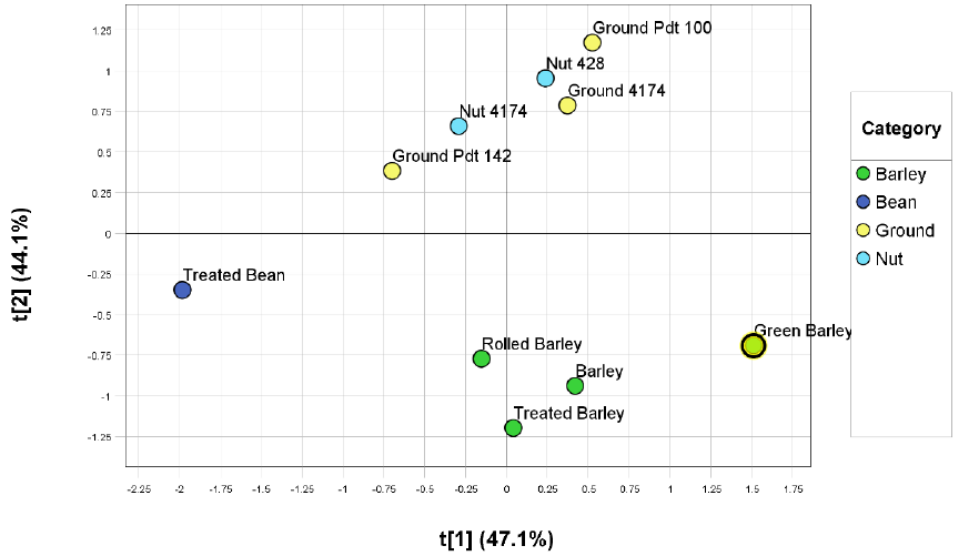
Low Scattering

Larger particle sizes

Process Analysis using Hyperspectral imaging

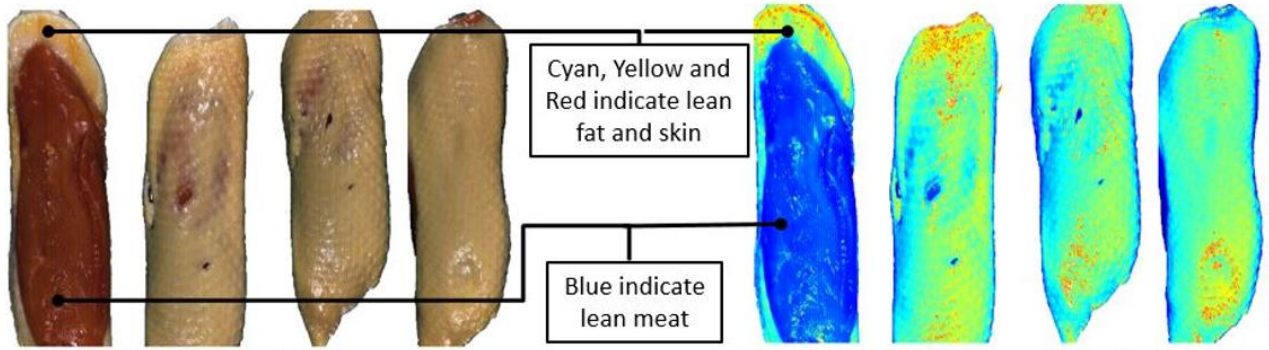






- Samples pass under the sensor
- Both spatial and spectral information is gathered
- Can teach the system to recognise different particles using a variety of parameters
- Quality control, contamination detection, conformity
- Overall system can be linked back to a central control and automation server

Food\Meat Industry

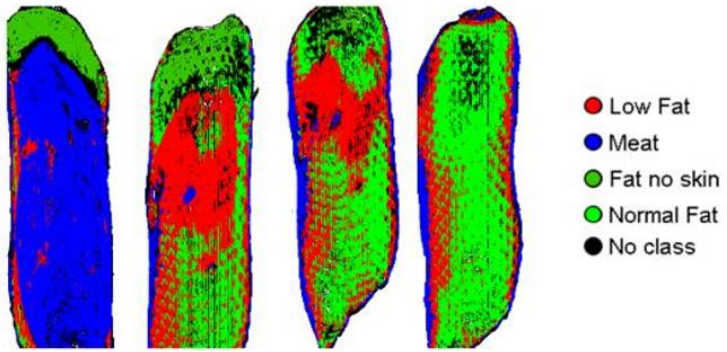


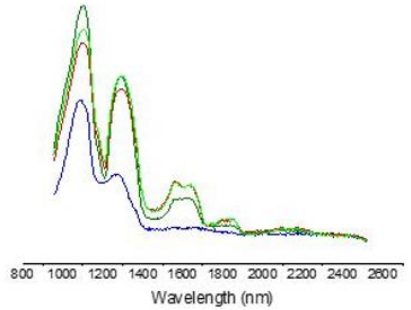
Visible image of duck meat

Principal Component Analysis of duck meat

2(C)

2(D)





Classification of low fat levels

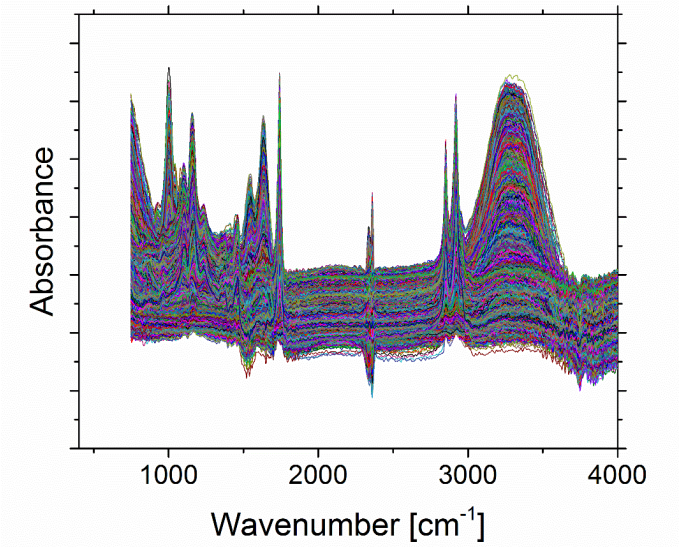
Reference spectra for each

- Multiple data points can be examined in short time space
- Both physical and chemical information can be obtained
- Use this data to feed back into the process or to categorise samples

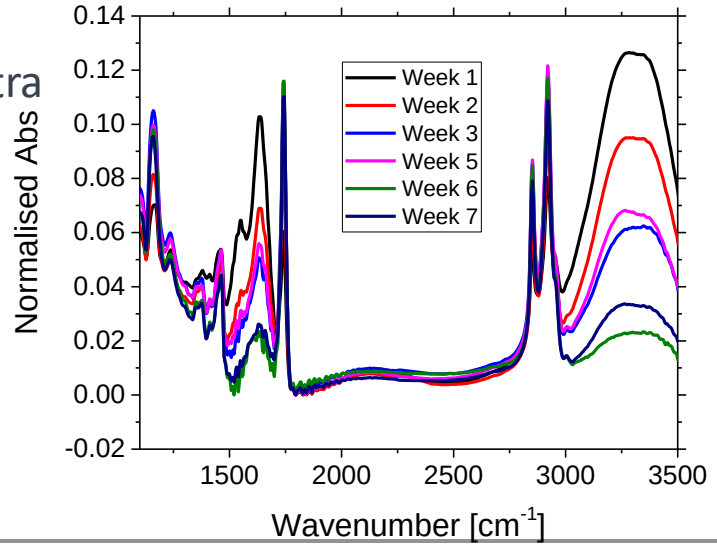
Mozzarella Cheese Maturity Cycle

NIR spectra collected from processed mozzarella cheese

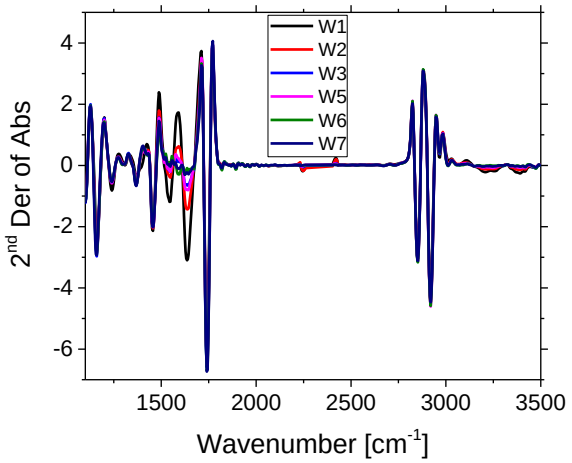
8000 spectra collected over 7 weeks

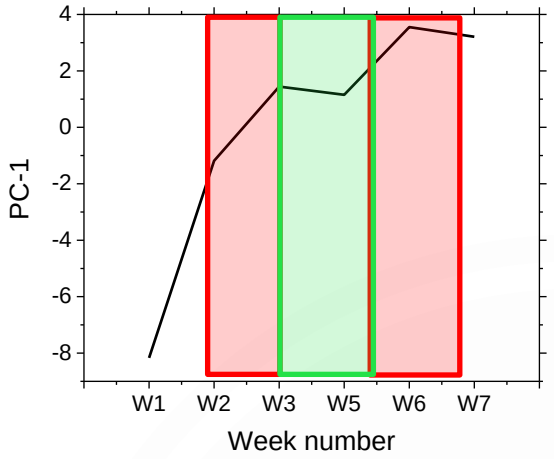


Average weekly spectra



Scores from the PCA





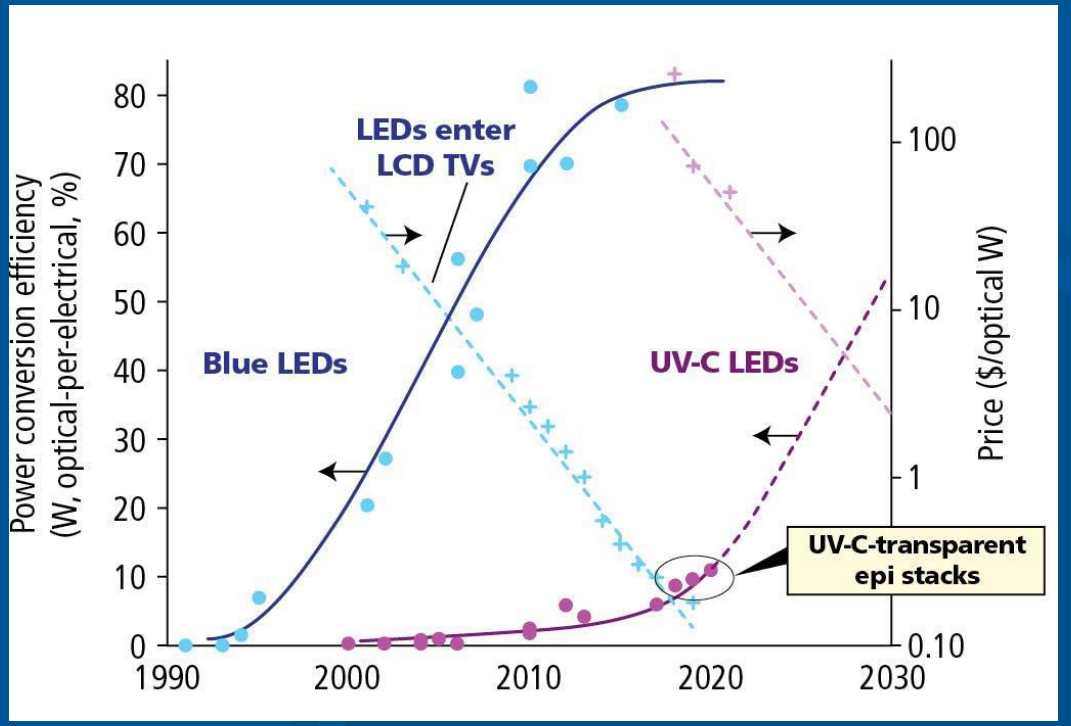
Optimum time to use cheese

Weeks 1-2 → Weeks 3-5 → Weeks 6+

Start of maturing cycle was dependent on the finished production date, but the Client did not always have this information

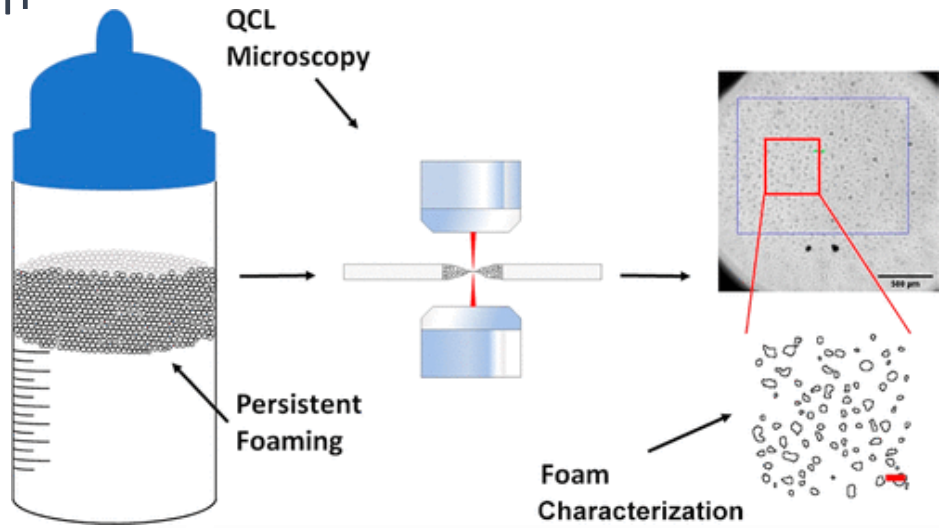
Application of UVC

- Innovative liquid food and ingredients processing technology using UVC LEDs
- We are setting out to develop a novel UVC LED based process device that is to replace thermal pasteurization of liquid ingredients and foods
- Project is targeted at liquid foods, dairy, and beverages processing industry
- 2 stage project over 24 months: stage 1- 15 months, stage 2- 9 months
- Jan 2024 and go on till Jan 2026



Infrared Microscopy and In Situ Infant Formula Foam Wall Characterization

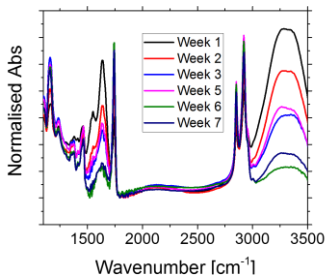
- QCL MIR microscopy - A technique that uses quantum cascade lasers to produce mid-infrared images of samples, revealing their chemical composition.
- Persistent foam in infant formulae - A problem that occurs when some infant formulae produce foam that does not dissipate after reconstitution, affecting the quality and safety of the product.
- Foam wall analysis - A method that measures the thickness, fat globule size and distribution, and macronutrient content of the foam wall, the layer that separates the foam from the liquid phase.
- Foam formation mechanisms - Multivariate curve resolution was applied to average MIR spectra calculated from the foam wall samples, and the relative macronutrient concentrations present were estimated. The foam wall thickness and water content provided the most useful data in relation to discussing the possible mechanisms driving the persistent foaming

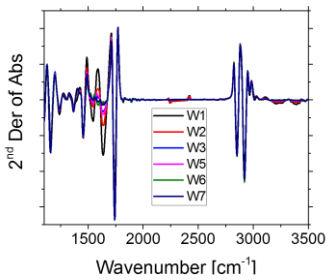


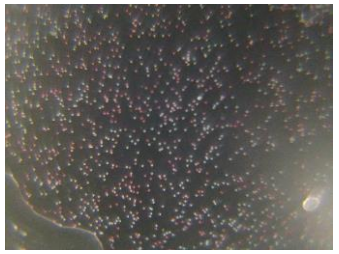
Applications of spectroscopy that can be applied to peripheral areas in the food processing industry

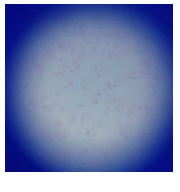
1. **Environmental Monitoring and Waste Management:**
   - **Wastewater Analysis:** Spectroscopic techniques can be employed to monitor the composition of wastewater from food processing plants. This helps in assessing the environmental impact and ensuring compliance with regulatory standards.
   - **Waste Characterization:** Spectroscopy can aid in characterizing solid waste generated during food processing, allowing for better waste management strategies.
2. **Cleaning and Sanitation:**
   - **Residue Detection:** Spectroscopy can be utilized to detect and identify residues from cleaning agents or sanitizers on equipment surfaces. This ensures effective cleaning practices and compliance with hygiene standards.
   - **Surface Contamination Analysis:** Spectroscopic techniques can be applied to assess the cleanliness of surfaces, identifying potential contaminants and residues.
3. **Packaging Analysis:**
   - **Quality of Packaging Materials:** Spectroscopy can be used to assess the quality and integrity of packaging materials. For example, it can identify potential defects or changes in material properties that could impact the shelf life of food products.
4. **Supply Chain Monitoring:**
   - **Traceability and Authentication:** Spectroscopic techniques can be applied to verify the authenticity of food products and ensure traceability within the supply chain. This is particularly relevant for addressing concerns related to food fraud and mislabeling.
5. **Occupational Health and Safety:**
   - **Air Quality Monitoring:** Spectroscopy can be employed to monitor air quality within processing facilities, ensuring a safe working environment for employees by detecting potential contaminants or airborne hazards.
6. **Sustainability and Carbon Footprint:**
   - **Greenhouse Gas Emissions Monitoring:** Spectroscopy can contribute to assessing the environmental impact of food processing operations by monitoring greenhouse gas emissions and supporting sustainability initiatives.

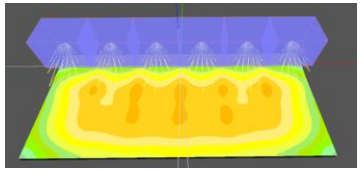
Short Study Examples

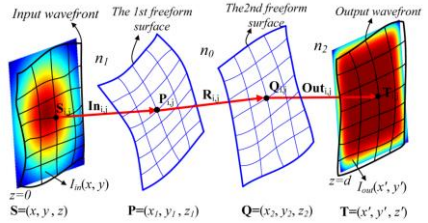


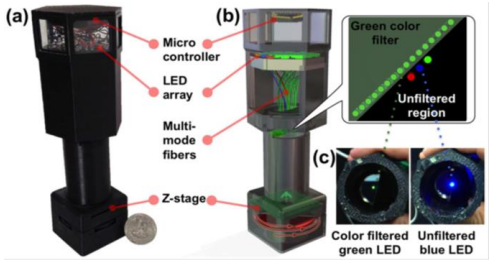


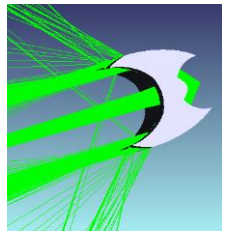


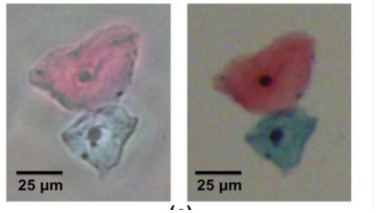












- *Point of care medical device*
- *Beverage quality monitoring device*
- *Optical blood pressure measurement device for heart surgery*
- *Oral bacterial decontamination device*
- *UV Water Purification system for aquaculture*
- *Development of a bacterial contaminant detection unit*
- *Challenge set development for product consistency*
- *Golf aid for shot alignment*
- *Optical design for emergency lighting*
- *UV disinfection unit for food and beverage*
- *Stability testing of cosmetics products*
- *Development of on-site infection detection system (Veterinary)*

CAPPA conducts ~ 50-60 Industry engagements per annum varying from

½ days to long term multi year collaborative projects, 500+ total projects

Contact Info

Thank you for your attention

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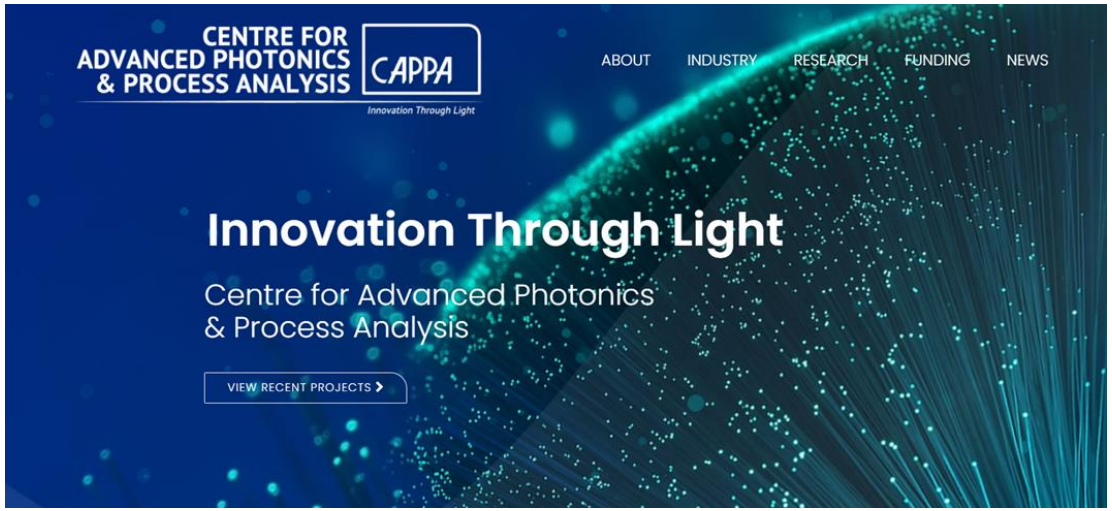

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