



THE OPPORTUNITIES OF PHOTONICS IN DEVELOPING THE FOOD INDUSTRY

Let's talk about Photonics and food production

How can we keep food production secure, healthy, sustainable and less wasteful, while trying to mitigate climate change and tackle population growth? One answer lies in Photonics. The technology has been called “the optical lifeline of our modern society” and has been recognized as one of Europe’s Key Enabling Technologies of the 21st century. Photonics technologies hold a key role in the ongoing transition towards the technology-driven Industry 4.0.

Photonics has been used in the food industry for a long time. Recently, though, the technology’s importance has grown tremendously throughout the production

chain – from farm to fork. Light is no longer merely a prerequisite for growth. Instead, it can be used to, for example, assess the amount of fertilizers and pesticides necessary, identify counterfeits and measure the ripeness of a fruit. And it’s fast. When it comes to Photonics, we’re truly talking about the speed of light.

The potential of Photonics in the food industry will grow as new applications are developed to tackle challenges along the supply chain. There’s much to be done, but also plenty of opportunities for collaboration within the industry. In this fact sheet, we will delve into this potential and ask you to help us fill in the gaps.

Hello, reader!

You’re holding a fact sheet produced by Food Tech Platform, an allied ICT Finland network orchestrated by the University of Turku, and Photonics Finland. This leaflet gives you an easily approachable overview of the potential of Photonics in the food industry. It covers the topic from four different points of view:

Keep reading to find out

- what some of the hottest research topics are
- whether you should invest in Photonics or not
- how Photonics technologies can help consumers
- who is regulating what, and how

See last page
for a quick
summary!



SCIENCE &
RESEARCH



BUSINESS



CONSUMER
BEHAVIOR



LEGISLATION



SCIENCE & RESEARCH

Photonics technologies advance food research in Europe

Photonics is applicable to every part of the food production chain. This means there's a myriad of research areas to dive into. In this chapter, we'll focus on the second link of the chain, farming, which also happens to be a very active field in European Photonics research.

Smart farming, agri-Photonics, precision agriculture, urban farming – if it has a name, you can be certain it's being studied. Developing Photonics technologies is crucial as farming becomes increasingly digital. Currently, in 2020, there are over 70 million Internet of Things (IoT) devices deployed worldwide for agricultural uses: tracking soil temperature, monitoring livestock health and reducing water consumption, among other things.

The agrifood industry has only quite recently adopted Photonics. However, the technology has made such an impact that the future of the industry can hardly be imagined without it. Like in many other industries, automation systems have partly replaced manual operations in agricultural

activities, too. Self-controlling machines and drones are already working in the fields, improving production by measuring crops and analyzing soil quality¹.

These automatic systems require optics that are necessary to enable 'sight' in different operations. This is where Photonics technologies, particularly imaging, enter the picture. Machine vision provides high resolution and high accuracy in a way that doesn't harm the crops. Imaging technology is popular especially in detecting bruises in fruit and vegetables, yield estimation and disease identification. Photonics enable rapid imaging systems that are both non-destructive and real-time².

More and more people live in cities, which means there's a growing need for diversifying where and how we grow food³. Urban farming is a great example of the usefulness of Photonics. In places where space and light are sparse, such as urban environments, the use of light-based sensorics and artificial light specifically tuned to enhance plant growth can increase yields and food quality.

WHAT IS PHOTONICS?

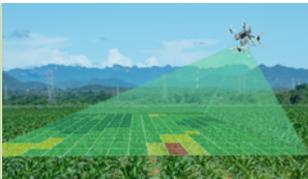
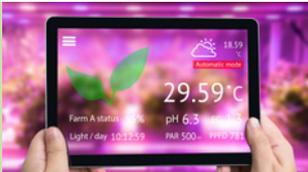
Photonics is the science, application and technology of generating, transmitting, modulating and detecting light. The term 'Photonics' combines two words: photon and opto-electronics. A photon is a particle of light.

When light hits the surface of an object, a range of processes occurs as light interacts with the surface and interior of the object. Photonics enables us to exploit these interactions and create new technologies that use the interactions to improve existing processes and create new ones.

Food value chain & Photonics



EXAMPLES OF THE USE OF PHOTONICS

<p>Remote Sensing for control and monitoring</p> 	<p>Sensing for food material detection and nutritional information</p> 	<p>Real time sensing food for monitoring, quality control, safety</p> 
<p>Real time packaging control and leakage monitoring</p> 	<p>Automation and self-controlling machines</p> 	<p>Smart Farming and Urban Farming</p> 
<p>Sensing for growing condition monitoring</p> 	<p>Sensing for harvesting</p> 	<p>Applications advising consumers on e.g. nutrition and food safety</p> 



BUSINESS

European Photonics is a goldmine of opportunity

From an investment standpoint, Photonics is something of a treasure trove. It is an enabling technology for the massive markets of IoT and quantum technology that will be increasingly prevalent in the future. In food production, specifically agriculture, it has been predicted that the amount of agriculture-related IoT sensors will reach 75 million in the next few years⁴.

GROWING PHOTONICS MARKETS

China is forecast to reach a projected market size of USD 170.1 billion by the year 2027, trailing a CAGR of 6.5% over the analysis period of 2020–2027.

Japan and **Canada** are forecast to grow at 6.5% and 5.7% respectively over 2020–2027⁵.

Within Europe, **Germany** is forecast to grow at approximately 5.7% CAGR.

In **Finland**, the estimated total revenue of the Photonics business is 1200–2300 million euros. The industry has grown over 40% since 2016⁶.

Europe is in a remarkable position globally when it comes to Photonics. The continent is the world's second largest producer of Photonics products, with an estimated 5000 companies in the sector.

Europe has been on the heels of the Asian-Pacific Photonics market, which has been estimated to continue its growth. In order to maintain its position, Europe needs strong leadership and investment in Photonics research and development. Below are some examples of world-class

European and Finnish players specializing in the optical measurement of food and raw materials. In Finland, spectroscopic measurement technologies and products in particular are far advanced.

- **Multiscan Technologies** provides solutions that combine conventional vision technologies and X-rays in order to solve the challenges in food safety with a single machine. First applied to sorting and selecting table olives, the arsenal now also covers varieties such as cherry tomatoes and pistachios.
- **Spectral Engines LTD** sells miniature spectrum sensors for industrial and agricultural needs. The company's matchbox-sized food scanner can measure the composition of a substance point by point by transferring collected data to a machine and a cloud service.
- **LED Tailor LTD** is a Finnish company that uses white and blue light for disinfection purposes. For example, blue light can be used to disinfect surfaces and air, making the premises sterile. These lighting techniques can also be used to sterilize cleanrooms or clean damp surfaces and biofilms. Both techniques are safe for humans.
- **Specim LTD** specializes in hyperspectral imaging. It sells spectral cameras that can be used to measure the distribution of a product's nutrient content directly on the production line or to classify products according to their quality.



CONSUMERS

Photonics technologies help consumers identify food fraud

In 2020, Interpol announced that more than 12000 tonnes of illegal and potentially dangerous food and drink items were recovered from markets, shops and transport inspections around the world. Interpol and Europol coordinated the operation that ran from December 2019 to June 2020. 40 million us dollars' worth of potentially harmful

items were seized, including food products falsely labelled as medicinal cures⁷.

Food counterfeiting is a growing global problem that threatens food security, consumers' health and the economy. There are two important trends in consumer behavior that are interesting in the context of these global issues. The first is that consumers are

placing more and more emphasis on food safety and value chain transparency.⁸

Photonics is useful for addressing these concerns. Since consumers are rarely experts in food production, easy-to-use handheld devices would enable consumers to identify potentially adulterated foods. The device could screen a food item, flag it as safe or unsafe and send the data for further scrutiny. After all, consumers are looking for simple ‘yes’ or ‘no’ answers to questions such as “is this food authentic, legal and safe?”

The second consumer trend is the rise of health-consciousness in the digital age. The increasing amount of health-conscious consumers has accelerated the market for wearables and smart mobile devices that help monitor vital signs⁹. Most of us have probably tracked our calorie intake or counted how many glasses of water we drink in a day, but Photonics could enable us to delve much

deeper into the foods we consume.

For example, imaging technologies could help identify the authenticity of food and possible foreign objects. As illustrated in the business section, companies are developing devices that are able to measure, for instance, the surface fat content of foods, or ensure that no stones or insects find their way into a bag of frozen vegetables.

Sounds futuristic, right? But wait, there’s more! The next goal for imaging technology is to enable consumers to check the freshness of supermarket food and count the calories of a restaurant meal using their smartphones¹⁰. Applications that use this measuring technology already provide consumers with an easy way to measure the nutritional content of their food, look for allergens and spot fake foods. This, in turn, could significantly improve eating habits and tackle issues such as obesity.



LEGISLATION

International standards and collaboration platforms improve food safety

Being an established Key Enabling Technology and bottomless well of opportunity, Photonics should be recognized in legislation. The technology’s role in improving a nation or continent’s commercial competitiveness alone should guarantee future investments in Photonics research and development¹¹.

In terms of the food industry and Photonics’ role in it, the technology has to comply with safety requirements. As mentioned earlier in this fact sheet, food safety is a fast growing global issue that threatens consumers’ health and at worst, the industry as a whole. The need for initiatives and concrete actions has been identified and partially answered.

For example, the Foundation Food Safety System Certification (FSSC) 22000 offers certifications for companies in the field of food production worldwide. Companies need to meet certain requirements (e.g. for hygiene) in order to become certified, and the certification has to be renewed after three years. Over 24000 certificates have been granted globally. The list includes 239 companies in Finland¹². This next bit gets a bit technical, but please bear with us.

One of the FSSC 22000’s three main requirements is the International Organization for Standardization’s 22000 standard for food safety management. This particular standard holds food producers accountable for their products and includes different requirements, ranging from communication and system management to hazard analysis – that is, identifying potential hazards and the operators responsible for controlling them. Generally, ISO has more than 1600 standards related to the food sector and many more in the pipeline¹³.

At its best, fighting food fraud is a collective and industry-wide effort, where also Photonics can play a role. Platforms, ecosystems, public private partnerships and movements help the field stay accountable. An example of this is the Global Food Safety Initiative (GFSI) that aims to build consumers’ trust in the food they purchase by improving safety management practices. As a ‘multi-coalition movement’, it leverages the power of retail, academia, manufacturing and government in tackling a pressing issue¹⁴. At the end of the day, it is unity that helps take the industry forward.

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Food Tech Platform Finland is a research-business network in Finland that brings together different actors from companies to the public sector. It aims to develop a sustainable Food System 2.0. by facilitating science-based food innovations and new business propositions. Food Tech Platform Finland is an Allied ICT Finland powered growth network and is orchestrated by the University of Turku.

Photonics Finland is a technology-oriented association that drives the Photonics industry in Finland. It connects Finnish Photonics companies, research centers, and public authorities. It is the single point of contact for the Photonics ecosystem in Finland. Photonics Finland is a member of Food Tech Platform Finland.

SUMMARY

THE OPPORTUNITIES OF PHOTONICS IN DEVELOPING THE FOOD INDUSTRY

Let's talk about Photonics and food production

We hope this leaflet has given you some food for thought. Take your time to digest it! But if you're feeling too full, you can take these bites with you.

SCIENCE & RESEARCH



Photonics technologies and research boost each link of the food production value chain. Imaging systems, sensors and IoT devices improve the quality and safety of the food we eat.

BUSINESS



From an investment standpoint, Photonics is a treasure trove. Europe is the world's second largest producer of Photonics products with around 5000 companies in the sector.

CONSUMER BEHAVIOR



Consumers are health-conscious and are placing more and more emphasis on food safety. Among other things Photonics technologies help them identify food fraud.

LEGISLATION



Global food safety standards help fight against food counterfeiting. Food producers are held accountable in various manners, which can be managed through Photonics solutions.

Let's start a dialogue!
Contact the Food Tech Platform Programme Leader Laura Forsman (laura.forsman@utu.fi), or Photonics Finland's Executive Director Juha Purmonen (juha.purmonen@photonics.fi).



 Photonics Finland

Leverage from
the EU
2014-2020 
European Union
European Regional
Development Fund


VARSINAIS-SUOMEN LIITTO
EGENTLIGA FINLANDS FÖRBUND
REGIONAL COUNCIL OF SOUTHWEST FINLAND

 UNIVERSITY
OF TURKU


functional foods forum