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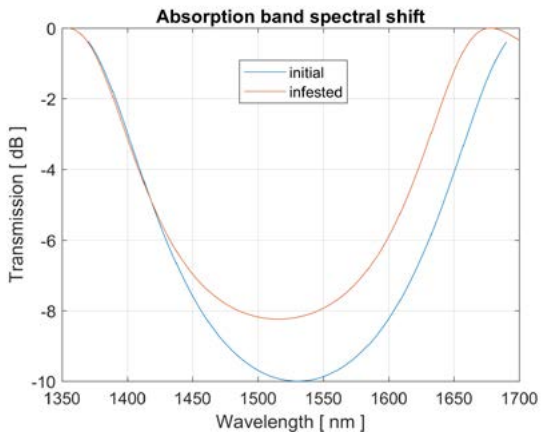
ECOLISENS

Long Period Grating Fibre Sensor Device for E. Coli Detection

Rapid and accurate detection of harmful bacteria is crucial to ensure food quality. In the Manunet project 'ECOLISENS' the partners National Institute of R&D for Optoelectronics - INOE 2000 (Romania), Grado Zero Innovation S.r.l. (Toscana, Italy), OOO Audit (Russian Federation) and S.C. Wing Computer Group SRL (Romania) have therefore collaborated on the development of a small size portable optic sensing device that can detect the presence of pathogenic E. coli using Long Period Fibre Grating Sensor (LPGFS). The advantage of the developed detection device is that it can also be used to identify other types of pathogenic bacterial strains or chemicals in the gas or liquid phase. Laurentiu Baschir, Senior Researcher of the Lasers and Fiber Optics Department: "With the innovation realised in the project, we are able to assess almost in real-time whether the E-coli bacterium is present in certain food products. Moreover, because we have developed a small portable device, the detection process no longer needs to be carried out by a specialist in a laboratory or hospital. This saves a lot of time and costs and generates maximum flexibility."

Early detection of E-coli bacteria

Although E-coli occurs naturally in the intestines of humans and provides protection against other harmful bacteria, there are some types that can cause problems in, for example, dairy products, raw meat and vegetables. “It is therefore important to detect these harmful strains of bacteria early, so that children who drink milk at school, for example, are not infected,” says Baschir. An important challenge was that the demonstrator had to detect the E-coli bacteria without physical intervention. “That’s why we opted for a Long Period Fibre Grating Sensor. The operation of this LPGFS device is based on ambient medium effective index variation induced by the presence of E.coli bacteria. With the refractive index, changes in wavelengths of the light beams in the fiber grid of the device are measured.”



Simulation model for measuring refractive index modifications

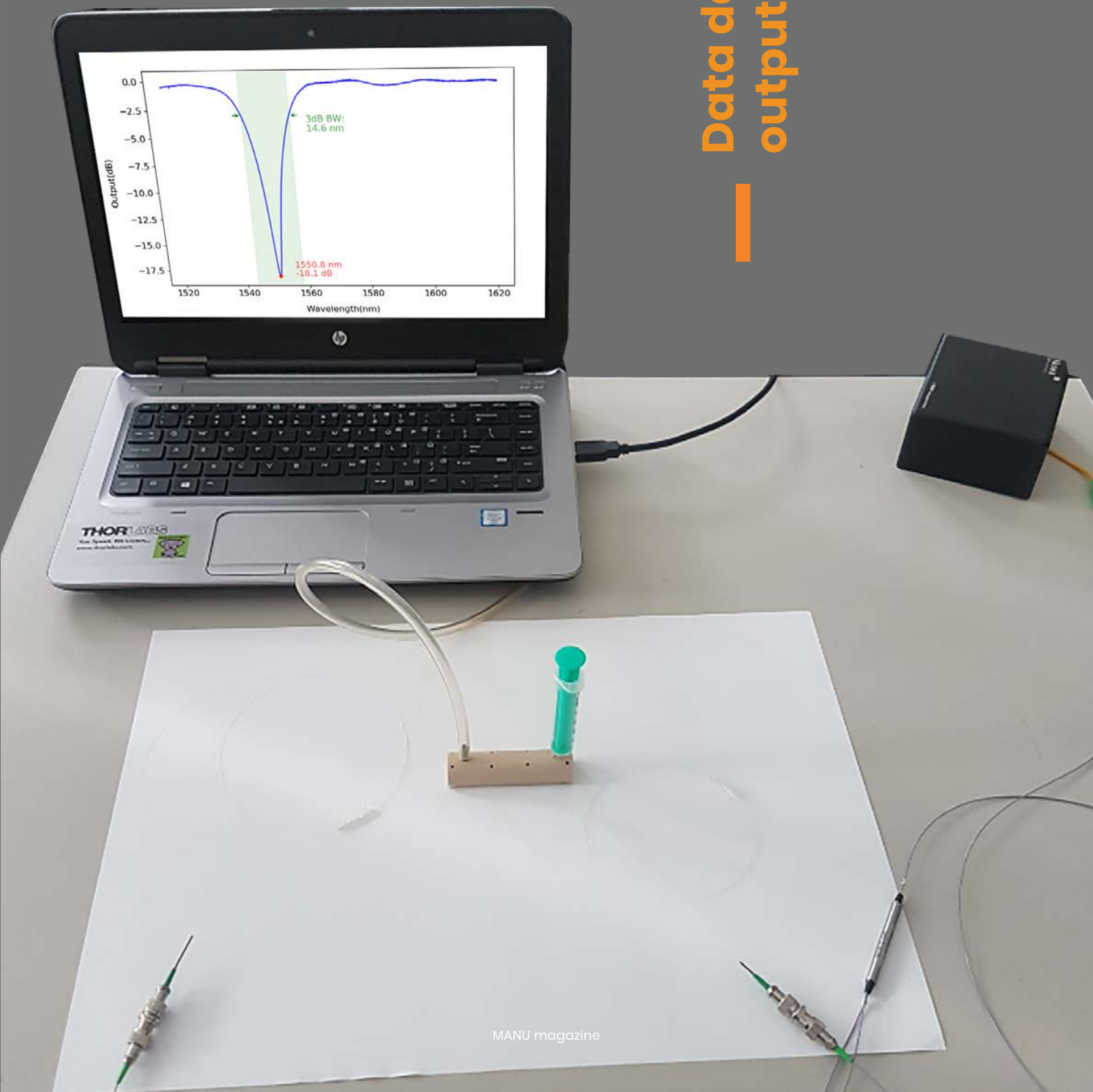
The determination of the refractive index plays a crucial role in detecting, for example, pathogenic E. coli bacteria in milk, Baschir emphasizes. “Indeed, all biochemical compounds of an E. coli bacterial strain have specific optical characteristics that enable accurate identification using optical detection equipment such as LPGFS. If we then also determine the refractive index of milk, we can identify the presence of E. coli in substances by comparing the specific measurements. The complexity is that the refractive index of milk has to be measured accurately. Because the refractive index of water, a part of milk, is already known, we can determine the exact values on the basis of the fat concentrations dissolved in the water. In order to achieve this, the development of an accurate simulation model that can predict changes in the refractive index of substance to be measured based on the presence of bacteria was required.”

Refractometric sensing device

The innovative character of the project is that the detection of the E-coli bacterium with the optic sensing device takes place almost in real-time. This drastically shortens the relatively long period between taking the samples and the results of the processing. According to Baschir, refractometric detection devices such as LPGFS operate on the basis of light field interactions and offer many advantages compared to standard technologies. These include higher sensitivity, immunity to electromagnetic interference and the possibility of location-independent testing. “The demonstrator we developed during the innovation project has a small volume measurement chamber where liquid phase samples potentially contaminated with E. coli bacteria are placed. The device further consists of a Sensor Interrogation Module (SIM) and a Data Acquisition and Processing

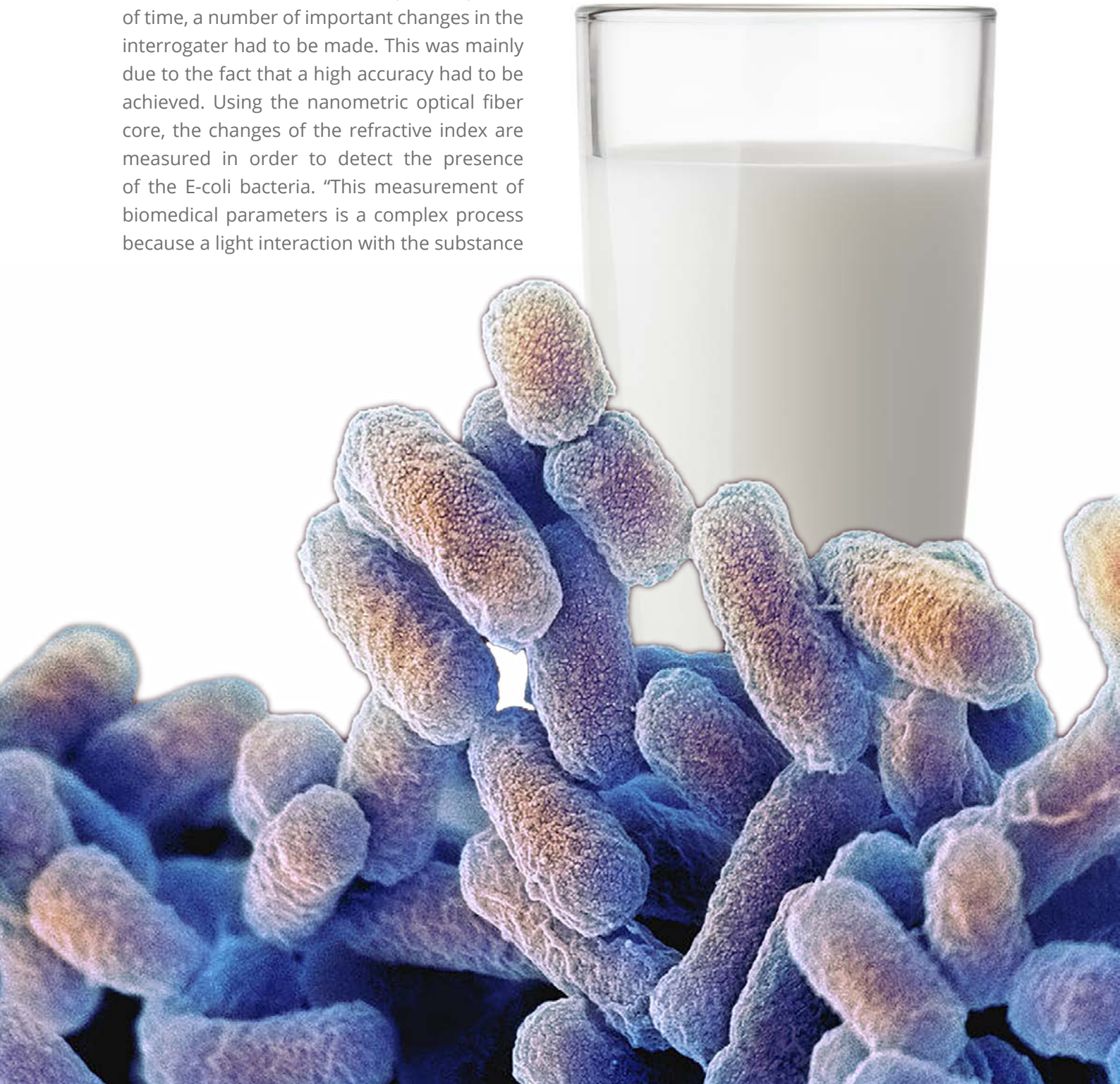
Unit (DAPU) needed to process the detection data. The detection process determines whether the refractive index of the LPGFS coating is greater, equal, or lower than that of the surrounding medium. If it turns out that the refractive index of the substance to be measured is equal to that of the E-coli bacteria, we know that there is a presence."

Data detection output



Integration of the interrogator

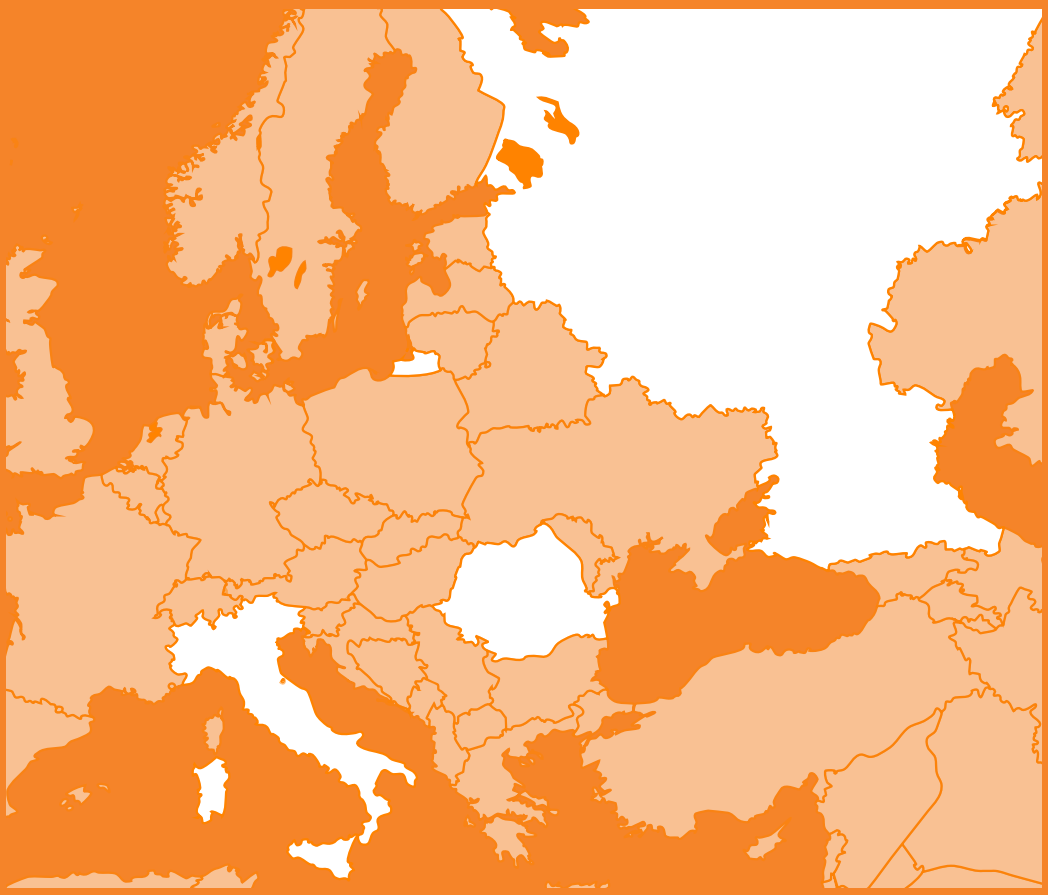
According to Baschir, the integration of the interrogator was a major challenge. “It had to be carefully connected to the fiber sensor device. Such interrogators are already available on the market and therefore we did not develop them ourselves during the innovation project.” However, due to the specific objective of detecting the presence of the E-coli bacteria within a very short period of time, a number of important changes in the interrogater had to be made. This was mainly due to the fact that a high accuracy had to be achieved. Using the nanometric optical fiber core, the changes of the refractive index are measured in order to detect the presence of the E-coli bacteria. “This measurement of biomedical parameters is a complex process because a light interaction with the substance to be measured, for example milk, has to be established,” Baschir emphasizes. “The light interaction in the optical fiber core is read out by the interrogator which then transmits the detection data to a connected computer. On this computer you can see if there is a presence of the E-coli bacteria in the investigated substance.”



Improvement of social health

"Before the start of the project, our objective was to develop a detection device that can contribute to improving food quality and people's health. As a project consortium, we are therefore very pleased that we were able to demonstrate the working principle of the optical sensing device. There was a fruitful collaboration during the innovation project. The participating partners already know each other from other European projects, which accelerated the process. At the end of the project, the companies in the consortium will start the production and further marketing of the detection device."

Laurentiu Baschir



Data detection output

Acronym
ECOLISENS

Call
Call 2017

Coordinating Funding Agency
UEFISCDI

Participating partners
National Institute of R&D for Optoelectronics - INOE 2000 (Romania)
Grado Zero Innovation S.r.l. (Toscana, Italy)
OOO Audit (Russian Federation)
S.C. Wing Computer Group SRL (Romania)

Project duration
24 months

Total project cost
€ 813.670

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"An interesting result of a project funded by UEFISCDI is the detection device developed within the ECOLISENS project, used not only for E. Coli detection but also for other types of strains or chemicals in the gas or liquid phase. We hope the collaborations strengthened during this project will continue successfully"

Nicoleta Dumitrache - UEFISCDI