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2025

06 Sen For Fire NEWSLETTER

SENFORFIRE. LOW-COST WIRELESS SENSOR NETWORK FOR FOREST FIRE PREVENTION AND EARLY DETECTION (S1/1.1/E0040)

Part of the SenForFire team on 7 May in Ávila, where tests were carried out with electrochemical gas sensors (SEC) and metal oxide semiconductor sensors (MOX).

In this issue:

Advances in sensors, testing and training

In the second quarter of 2025, the SenForFire Interreg Sudoe project made significant progress. The second follow-up meeting with all beneficiaries took place in Barcelona, reviewing progress and planning the deployment of sensors. The pilot areas of Sierra de Gata (Extremadura) and Guadarrama (Madrid) were visited to monitor the moisture content of live forest fuels and the upcoming installation of soil moisture sensors. In Ávila (Castilla and León), controlled burns of debris and plant material were carried out to evaluate various technologies for airborne gas and particle sensors, developing ultra-low consumption prototypes with environmental sensors and long-range LoRa communication.

In the academic field, an Erasmus Mundus master's degree and a MOOC on intelligent data analysis for fire prediction were proposed. The first articles on prototype evaluation were accepted at the EXPAT'25 international conference (September), which will include a special session on innovation in forest fire prevention. The project was also presented at the 9th Spanish Forestry Congress, and a poster was designed and printed to publicise the project, the pilot areas, the monitoring campaigns and the sensors used.

Interreg Sudoe
Co-funded by the European Union
SenForFire

Coordination: Macarena Parejo (B6)
macarenapc@unex.es

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Informative poster on pilot areas and fire prevention and early detection tests with RIS for 2025. A poster has been designed and produced showing the pilot areas of the project, as well as the fire prevention and early detection tests using the RIS system, which will be implemented and developed in these areas during 2025.

To facilitate its dissemination and accessibility, versions in Spanish and English have been prepared, which have been printed in roll-up format, measuring 85 cm wide and 206 cm high.

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Social media management. Creation and publication of weekly content on Facebook, LinkedIn and X profiles, on the progress of the project and other topics related to its innovation objective.

The project has a presence on Instagram through external accounts and has had some impact: @uni.extremadura.

PRESS CLIPPINGS

Fórum, Huffington Post, El Periódico de Extremadura, Diario de León, Delta 13 News, Digital Extremadura

Click on the image to see the news.

CTG CROSS-CUTTING TASK GROUP: PROJECT MANAGEMENT AND COMMUNICATION — MANAGEMENT

Coordination: Esther Hontañón (B1)
esther.hontanon@csic.es

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8-9

Project follow-up meeting in Barcelona (Catalonia). On 8 and 9 April, the second project follow-up meeting was held in Barcelona. The Barcelona Institute of Microelectronics (IMB-CNM-CSIC) hosted the meeting, which was attended by around thirty people representing all the project beneficiaries. The meeting showcased the progress made by the various task groups since the previous biannual meeting (Fundao, September 2024) and outlined the objectives and work plan for the second and third quarters. The latter will focus mainly on the deployment of the wireless sensor network (RIS) to begin fire prevention testing in the pilot areas.

SenForFire team at the follow-up meeting, Barcelona.

During the meeting, ICIFOR-INIA-CSIC gave a technical presentation entitled 'Soil moisture measurement techniques and their application to wildfire prevention'.

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Expense report. Most of the project beneficiaries submitted their second expense report on eSudoe, covering the period from January to May 2025.

WG1 SPECIFICATIONS OF THE VALIDATION SCENARIOS AND TECHNICAL CHARACTERISTICS OF THE WSN

Coordination: Mercedes Guijarro (B2)
guijarro@inicia.csic.es

MAY
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A 1.1. Guadarrama pilot area (Community of Madrid).

A 1.1

The ICIFOR-INIA-CSIC, ITEFI-CSIC and Ray-IE teams visited the Guadarrama pilot area (Community of Madrid), which was incorporated into the SenForFire project as a result of the interest shown by the Directorate-General for Emergencies of the Community of Madrid (DGE) in the project for the installation of soil moisture sensors in this area.

In this area, ICIFOR-INIA-CSIC has been monitoring the moisture content of live fine forest fuels for years, in collaboration with the aforementioned DGE.

Coordination: Lionel Presmanes (B11)
lionel.presmanes@univ-tlse3.fr

A 2.1

APRIL

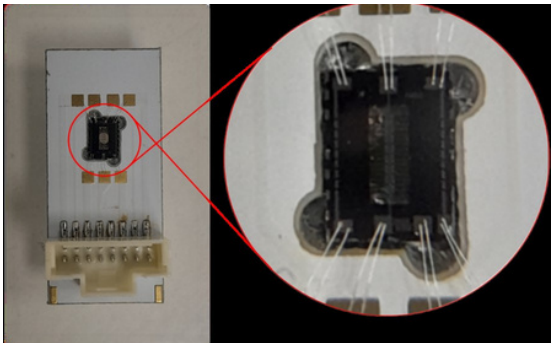
Scientific collaboration. CIRIMAT-CNRS and IMB-CSIC are collaborating on the integration of thin films on silicon platforms, with the aim of studying their thermoelectric properties.

MAY

Hydrogen sensors based on niobium-modified TiO_2. CIRIMAT and LAAS at the CNRS have developed new sensors using titanium oxide (TiO_2) modified with niobium (Nb), which are highly sensitive to hydrogen. Tests are currently being carried out with other gases to assess possible cross-reactivity and validate their selectivity.

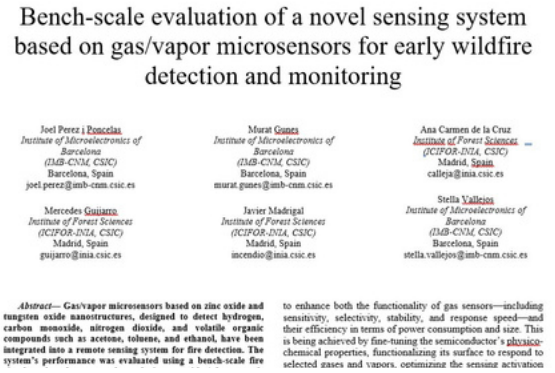
Lionel Presmanes, from CIRIMAT-CNRS, explains the devices at the bi-monthly follow-up meeting.

Integration of air flow sensors into electronic modules. The IMB-CSIC has successfully integrated several air flow sensors into printed circuit boards (PCBs), enabling them to be connected to electronic modules. Laboratory tests are being carried out to calibrate the sensors and determine the signal saturation point, in order to establish the maximum wind speed they can measure.



One of the CSIC-IMB flow sensors integrated into the PCB for coupling with the electronic module.

Scientific publication in EXPAT'2025. The article entitled 'Bench-scale evaluation of a novel sensing system based on gas/vapor microsensors for early wildfire detection and monitoring', developed by researchers from IMB-CSIC and INIA-CSIC, has been accepted for presentation at the EXPAT'2025 conference, within the special session Innovation in Forest Fire Risk Management (IFFRM'25), and will be published shortly in IEEE Xplore®.



Bench-scale evaluation of a novel sensing system based on gas/vapor microsensors for early wildfire detection and monitoring

Joel Perez i Poncelas
Institute of Microelectronics of Barcelona (IMB-CNM, CSIC)
Barcelona, Spain
joel.perez@imb-cnm.csic.es

Murat Gunes
Institute of Microelectronics of Barcelona (IMB-CNM, CSIC)
Barcelona, Spain
murat.gunes@imb-cnm.csic.es

Ana Carmen de la Cruz
Institute of Forest Sciences (ICIFOR-INIA, CSIC)
Madrid, Spain
calleja@inia.csic.es

Mercedes Guijarro
Institute of Forest Sciences (ICIFOR-INIA, CSIC)
Madrid, Spain
guijarro@inia.csic.es

Javier Madrigal
Institute of Forest Sciences (ICIFOR-INIA, CSIC)
Madrid, Spain
incendio@inia.csic.es

Stella Vallejos
Institute of Microelectronics of Barcelona (IMB-CNM, CSIC)
Barcelona, Spain
stella.vallejos@imb-cnm.csic.es

Abstract— Gas/vapor microsensors based on zinc oxide and tungsten oxide nanostructures, designed to detect hydrogen, carbon monoxide, nitrogen dioxide, and volatile organic compounds such as acetone, toluene, and ethanol, have been integrated into a remote sensing system for fire detection. The system's performance was evaluated using a bench-scale fire

to enhance both the functionality of gas sensors—including sensitivity, selectivity, stability, and response speed—and their efficiency in terms of power consumption and size. This is being achieved by fine-tuning the semiconductor's physico-chemical properties, functionalizing its surface to respond to selected gases and vapors, optimizing the sensing activation

Excerpt from the article accepted at EXPAT'2025, developed by CSIC-IMB and CSIC-INIA.

Technical follow-up meeting for Activity A2.1. The bi-monthly meeting for Activity A2.1 was held, focusing on sharing progress in the manufacture of gas, air flow and infrared microsensors, as part of the technical follow-up of the project.

Submission of technical documentation on the eSudoe platform. The partners involved in activity 2.1 have completed deliverables 2.1.1 and 2.1.2, which were submitted together with the technical report and the second statement of expenditure from the IMB-CSIC via the eSudoe platform at the end of May.

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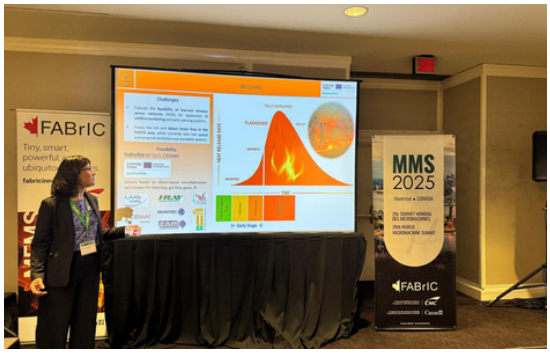
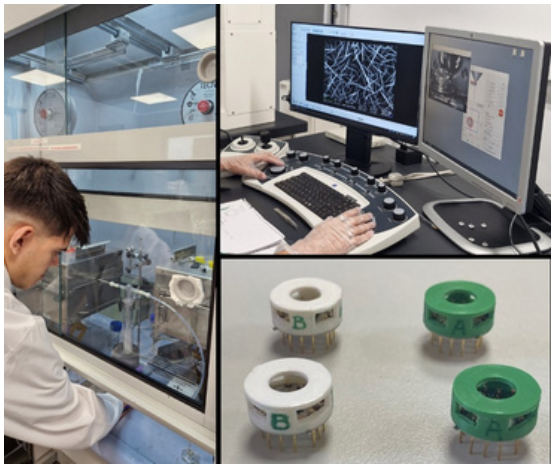
PParticipation in MMS 2025. The IMB-CSIC, as part of the Iberian delegation, participated in the 28th World Micromachine Summit (MMS 2025), held in Montreal (Canada) from 2 to 5 June. During the event, the project's progress was presented, highlighting the key role of micro-machined devices in the development of smart sensor networks for large-scale forest fire monitoring. More information: mms2025.ca



Presentation at MMS 2025 by the iberian delegation on advances in intelligent systems, microsystems and sensors.

Delivery of new generation of micro-sensors. The IMB-CSIC has completed the manufacture of a new generation of gas micro-sensors and has shipped them to the company RAY Ingeniería Electrónica (RAY-IE). These sensors will be integrated into electronic modules that will be installed in the upcoming pilot tests of the project.



Second generation of IMB-CSIC gas micro-sensors sent to RAY-IE for integration into electronic modules (bottom right corner), along with images of the deposition of sensitive nano-materials and their characterisation using electron microscopy.

A 2.2

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Testing begins to extend the battery life of SEC modules. Methods for extending the battery life of electrochemical gas sensors (SEC) have begun to be evaluated, exploring configurations that allow for continuous operation with solar panels.

Completion of the ULP prototype with indefinite autonomy. UEx has completed the development of the ultra-low power (ULP) prototype, a compact, low-cost module that incorporates solar charging and BME688 and ENS161 sensors for measuring volatile organic compounds (VOCs), temperature, humidity, and atmospheric pressure.

The device transmits data using LoRa technology and achieves indefinite autonomy thanks to its optimised design, which reduces the number of components required.

ULP prototype developed by the UEx.

A 2.4

MAY

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Field testing of sensors, Ávila (CyL). On 7 May, field tests were carried out in Ávila, in which six SEC modules (electrochemical sensors for CO, NO_2 and VOCs) and four MOX modules (VOC sensors) were evaluated again. The tests consisted of burning different materials grouped into piles. Although the high humidity of the fuel made ignition difficult, satisfactory measurements were obtained when the smoke was carried by the wind towards the sensor area. In addition, the correct transmission of data through the LoRa communication module was verified, using the gateway deployed on site by Arantec.

Field sensor tests carried out on 7 May in Ávila. On the left, general view of the test area in the Vicolozano industrial estate and environmental monitoring during several controlled burns (right), where SEC and MOX gas sensors installed on a pole (centre) were evaluated, exposed to real concentrations of gases and VOCs.

Fuel characterisation.
ICIFOR-INIA-CSIC participated in the tests carried out in Ávila, characterising the plant debris and materials used as fuel.

Burning of remains in Ávila.

Completion of technical deliverables 2.2.1 and 2.2.2, which include the system architecture and detailed description of the hardware components involved.

A 2.5

JUNE

16-20

Presentation of the project at the 9th Spanish Forestry Congress. ICIFOR-INIA-CSIC participated in the 9th Spanish Forestry Congress, held in Gijón (Asturias), where it presented a poster entitled 'Prevention, detection and monitoring of forest fires using low-cost wireless networks: the SenForFire project'.

Poster presented.

R.2.1

APRIL

Presentation of the master's degree to the EU. Participation in the 2nd project follow-up meeting, with the presentation of the process of submitting the proposal for the Erasmus Mundus Joint Master's Degree in Intelligent Data Analysis for Environmental Sensor Networks (EMJM-MIDA-ESN) to the European Union.

MAY

Proposal for a MOOC module on Intelligent Data Analysis applied to Forest Fire Prediction.

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Revision of the master's degree in accordance with the 'European approach', following the recommendations of the Portuguese National Accreditation Agency, in order to comply with the requirements of the so-called 'European approach'. The proposal will be resubmitted.

WT2 DEVELOP AND MANUFACTURE COMPONENTS AND SYSTEMS AND VERIFY THE PERFORMANCE OF WSN

MAY

Organisation of the IFFRM'25 session at EXPA'25. The University of Coimbra is participating in the organisation of the special session 'Innovation in Forest Fire Risk Management (IFFRM'25)', as part of the upcoming international conference EXPA'25 (Experiment@ International Conference 2025), in September. More information: https://expat.org.pt.

WT3 VALIDATING WSN FOR THE PREVENTION AND EARLY DETECTION OF FOREST FIRES

Coordination: Jesús Lozano Rogado (B6)
jesuslozano@unex.es

A 3.2

MAY

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Coordination and deployment of WSN in pilot areas. During this quarter, ICIFOR-INIA-CSIC and the project's technology partners (ITEFI-CSIC, Ray-IE and Arantec) participated in coordination meetings with forestry agents involved in the pilot areas of the Community of Madrid, Extremadura and Fundão (Portugal), with the aim of planning the activities corresponding to the second half of 2025 within the framework of Activity 3.2: 'Deployment of wireless sensor networks (WSN) in pilot areas and verification of their operation'.

They also visited the pilot areas of the Sierra de Gata (Extremadura), in the municipalities of Cañaveral, Coria and Mirabel, chosen for vegetation sampling to determine the moisture content of live fine fuels and to monitor soil temperature and moisture.

During the visit, ICIFOR-INIA-CSIC provided the staff of the INFOEX Plan of the Regional Government of Extremadura and the Forest Fire Prevention and Analysis Team (EPAIF) of Cáceres —under the Ministry for Ecological Transition and Demographic Challenge (MITECO)— with the instructions and materials necessary to carry out periodic monitoring of the moisture content of live fine fuels in the areas where the soil sensors will be located.

Vegetation sampling to determine the moisture content of live fine fuels in the Sierra de Gata pilot area (Extremadura).