



UNIVERSITAT POLITÈCNICA
DE CATALUNYA
BARCELONATECH

[OPTICS AND PHOTONICS]

RESEARCH, DEVELOPMENT & INNOVATION AT THE UNIVERSITAT POLITÈCNICA DE CATALUNYA - BARCELONATECH (UPC)

The Universitat Politècnica de Catalunya - BarcelonaTech (UPC) specialises in engineering, architecture, science and technology, including technologies applied to Optics and Photonics. In this field, our main areas of work are:

- Advanced optical metrology
- Optomechanical design and systems engineering
- Prototyping of photonic sensors
- Visual optics and ophthalmic instrumentation
- Radiometry and photometry
- Biophotonics and biomedical applications
- Multispectral and hyperspectral imaging
- High-Quality Plastic Optical Component Manufacturing
- Energy, communications and Industry 4.0

As a result of UPC's well-established research track record in its fields of expertise, we can offer a wide range of services in:

- R&D technology transfer projects
- Consortia for national and Horizon Europe projects
- Patents
- Technology assessment
- Specialised facilities

UPC is a leading university in Spain in terms of research volume and technology transfer to industry, and one of the largest knowledge hubs in Southern Europe.

ADVANCED OPTICAL METROLOGY

Development of optical systems for precise measurement of shapes, surfaces, and optical properties using light

- Interferometry and profilometry for 3D measurement of objects and surfaces
- Phase-Shifting Interferometry and Self-Mixing Interferometry
- Thickness measurement systems for coatings and thin films
- Solutions for industrial inspection, quality control, and component manufacturing
- High-definition Time-of-Flight (ToF) sensors for distance and depth measurement
- High-resolution, high-speed LIDAR sensors
- Confocal profilometry
- Structured light patterns
- Photogrammetry for 3D measurements and data
- Holography
- Ellipsometry
- Speckle metrology: measurement of deformations, displacements, object shape, surface roughness, vibrations, and dynamic phenomena with wavelength-scale sensitivity
- Optical testing

OPTOMECHANICAL DESIGN AND SYSTEMS ENGINEERING

Design and integration of optical and mechanical components into customised precision instruments

- Simulation and design of optical systems and associated mechanical components (cameras, telescopes, microscopes, laser systems, etc.)
- Optimisation and validation of optical systems
- Integration into robust systems for industrial environments
- Diffraction simulation and analysis
- Coherent light propagation
- Free-form optical design

PROTOTYPING OF PHOTONIC SENSORS

*Desenvolupament de sensors i instruments
Development of application-specific sensors and instruments based on optical technology*

- Optical, mechanical, and electronic design
- Design, construction, and validation of optomechanical prototypes integrating optics, mechanics, and electronics
- Software and firmware development



VISUAL OPTICS AND OPHTHALMIC INSTRUMENTATION

Photonics applied to vision improvement and optical device development

- Systems for measuring and diagnosing visual defects
- Adaptive optics
- Wavefront sensing for measuring optical aberrations of the eye
- Development of technologies for smart glasses, lenses, and advanced AR/VR devices
- High-speed, high-precision colour measurement
- Optical Coherence Tomography (OCT)
- Optical characterisation and simulation of intraocular lenses for visual quality enhancement

RADIOMETRY AND PHOTOMETRY

Measurement of electromagnetic radiation and light for scientific and industrial applications

- Characterisation of light sources, displays, and sensors (brightness, colour, colour temperature)
- Calibrated systems for pre-validation of standards (ISO, IEC)
- Solutions for lighting, automotive, solar energy, entertainment, and telescopic industries



BIOPHOTONICS AND BIOMEDICAL APPLICATIONS

Optical technologies for medicine and biology

- Non-invasive medical imaging systems: high-resolution tissue and cell imaging, biomolecule detection, and light-based therapies
- Biomedical photonics and machine learning for diagnosing and treating ocular dysfunctions, cognitive decline, and haematological diseases
- Development of optical sensors for biomarker and physiological parameter detection
- Fluorescence microscopy
- Hyperspectral image analysis
- Visual optics and ophthalmic instruments
- Biomedical and environmental monitoring
- Gas detection
- Precision agriculture
- Optical systems for pest detection
- Optical spectroscopy for biological applications
- Miniaturised photonic systems for biochemical analysis and diagnostics

MULTISPECTRAL AND HYPERSPECTRAL IMAGING

Image capture and analysis across different wavelengths for material and environment characterisation

- Remote sensing: mapping of vegetation, water bodies, and other elements via satellite
- Medical imaging: aiding disease diagnosis (e.g., cancer) by identifying changes in tissue spectral signatures
- Cultural heritage: non-invasive examination of paintings, artefacts, and objects
- Security: detection of explosives and hazardous chemicals
- Precision agriculture
- Custom camera and image processing system development
- Integration into drones, robots, or production lines
- Industrial instruments for spectral and colour analysis
- Colorimetry and photometry: colour matching and control
- Algorithm development (noise correction, spectrum recovery)
- Infrared (IR) sensors
- Spectroscopy

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HIGH-QUALITY PLASTIC OPTICAL COMPONENT MANUFACTURING

Design and production of plastic optical components using highly precise injection moulding processes

- Manufacturing systems for large-scale integrated optical and photonic components using thermoplastics, applicable to:
 - Lighting (LEDs)
 - Communications (Plastic Optical Fibre – POF)
 - Sensors integrating light sources or detectors
- Validation and quality control using precision optical measurement systems

ENERGY, COMMUNICATIONS, AND INDUSTRY 4.0

- Transparent photovoltaic coatings for building façades
- High-efficiency, high-power-density germanium devices for low-cost thermophotovoltaic applications
- Secure quantum communication technologies using integrated photonics at large scale
- Reliable and secure end-to-end architectures for next-generation high-capacity optical networks
- Cutting-edge robotic vision and control technologies for dynamic environments, applicable to:
 - Drones and autonomous vehicles
 - Humanoid or multi-degree-of-freedom robots
 - Industrial applications with precision control and critical response time requirements



APPLICATION AREAS

- MANUFACTURING INDUSTRY
- HEALTHCARE AND MEDICAL
- ENERGY AND ENVIRONMENT
- AUTOMOTIVE AND MOBILITY
- ROBOTICS
- ELECTRONICS
- BIOMEDICINE
- INSTRUMENTATION
- UNMANNED AERIAL VEHICLES (UAVS)
- AEROSPACE
- GRAPHIC ARTS
- COSMETICS
- FOOD INDUSTRY
- AGRICULTURE



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