

# **Establishing an Excellent Research Cluster in Southern Taiwan-Photonic Valley**

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# Abstract

We have established Photonic Valley, a collaborative project in Southern Taiwan based on Taiwan Consortium of Emergent Crystalline Materials (TCECM) laser spectroscopic technology service platform. This initiative aims to promote interdisciplinary collaboration among TCECM-funded laboratories in Southern Taiwan. The primary goal of Photonic Valley is to support our members in synthesizing high quality emergent crystalline materials, advancing cutting-edge scientific research, and implementing industry applications through our professional laser spectroscopic technology services. We have delivered four distinct laser spectroscopic systems to laboratories at National Sun Yat-sen University (NSYSU), National Cheng Kung University (NCKU), and National Pingtung University (NPTU). Each system is designed for specific applications, including photoluminescence (PL) and Raman Spectroscopy with multiple degrees of freedom for analyzing various crystal facets, 3D laser scanning confocal spectroscopy for cell imaging, time-resolved PL, and scanning confocal imaging for magnetic circular dichroism. We believe that these advanced laser spectroscopic technologies will provide invaluable technical services and training opportunities for the local research community. Ultimately, we aim to foster the localization of technology in Southern Taiwan.

### Mission

### Integration and Sharing of Research Resources **Promote Interdisciplinary Research Collaboration**

- Through the combined efforts of key technology teams in crystal growth, outstanding academic research teams, and industry application teams in Southern Taiwan, we aim to demonstrate once again the feasibility and sustainability of the "TCECM Spectral Technology Service Platform".
- Establish "local" talent development programs.
- Cultivate a "local" photonics research community (Photonic Village), which will be the key to grounding and embedding this technology.
- Serve as a new paradigm for Taiwan's fundamental scientific research process.



**Research Topic:** Raman and Second-Harmonic Generation (SHG) Measurements of Metal **Chalcogenide Nonlinear Optical Crystals.** 

Method: By tuning the covalent bond between the transition metal B and the anion X in ABX<sub>3</sub>, to control the band structure and nonlinear optical properties of the grown crystals. Establish singlecrystal microscopic techniques to perform Raman and second-harmonic generation (SHG) spectroscopy measurements on the single crystals. **Goal:** Establish the capability to perform crystal

face identification on novel material crystals using the SCXR platform, and conduct Raman and secondharmonic generation (SHG) spectroscopy measurements along the crystal face directions.

Research Topic: Establish a cell observation platform using Ramanfluorescence co-located 3D imaging microscopy technology.

Method: Customize a LSCSM equipment and image analysis software to ensure accurate white light/SERS/fluorescence 3D imaging measurements and image merging and reconstruction.

**Goal:** Verify a novel technique that allows for simultaneous tracking of subsequent protein expression after stimulating cells, helping biological scientists explore complex cellular behaviors in greater depth.

**Research Topic:** Epitaxial growth of Group III

Method: Establish a TRPL system with 355 nm /

266 nm laser sources to investigate the

recombination mechanisms of photoexcited

carriers in defects/impurities within GaN and

**Goal:** Understand the correlation between the

growth parameters and structural effects of Group

III nitride epitaxial growth and their fundamental

characteristics, in order to optimize the quality of

nitride films for better optoelectronic device

nitride and its optical research.

AlGaN materials.

performance.

國立中山大學

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#### **Research Topic:** TCECM Spectral Technology Service Platform.

Method: Assist each sub-project in developing customized laser spectroscopy measurement technologies, including laser scanning confocal spectroscopy microscopy, quantifiable SERS chip technology, two-photon fluorescence, optical second-harmonic generation, and in-situ micro-Raman spectroscopy measurements.

#### Goal:

**Collaboratively explore the research topics set by** each sub-project. Technology sharing, collaborative research. Establish a photonics community in the southern part of Taiwan.



**Research Topic:** Development of an in-situ fast scanning energy analysis magneto-circular dichroism imaging system.

## **Operation Model**

- Using the "TCECM Spectral Technology Service" Platform" established by the project's principal investigator as the cohesive core, invite the leaders of key research laboratories in Southern Taiwan with outstanding academic performance to join as co-principal investigators.
- Through the development of customized or functionalized laser spectral microscopic imaging measurement technologies, we introduce interdisciplinary research projects in the subprojects, focusing on four research areas: single crystal growth, biomedical characterization, semiconductor materials, and novel materials.
- The technology service platform will



- The overall execution goals of the project are planned as follows:
- Initial goal: The focus will be on aligning the research philosophies and expectations among the members, ensuring the smooth operation of the platform's technical services.
- Mid-term goal: Develop the distinctive TCECM customized and innovative spectroscopy technologies, forward-looking research perspectives, and locally originated research outcomes, achieving the project's purpose of "technology sharing and collaborative research".
- Final goal: Connect the four outstanding research group laboratories, forming a laser



technology to enhance spatial resolution and scanning speed, and establish a high-resolution insitu fast scanning energy analysis MCD imaging system.

**Use MCD to observe Spin/Orbit Hall effect.** Magnetic optical imaging studies with energy analysis.

novel 2D materials.

**TCECM Laser Spectroscopy** Measurement Technology Service Platform Photonics Cluster in the Southern Taiwan Serving the local scientific research community



Method: Integrate the existing MCD spectroscopy imaging system in the laboratory with LSCM Goal:

Investigation of spin-polarized band structure in

simultaneously incorporate "localization" of "research talent development" and "research outcome promotion" as part of the platform's operational components.

Comprehensively link the balanced development of outstanding scientific research (academia), research talent development (education), and industry promotion and application (industryacademia collaboration) in Southern Taiwan.

## **Project Features**

By using the customized laser spectroscopy technology as the cohesive core, and through the team consensus of "technology sharing and collaborative research," foster opportunities for collaboration across academic disciplines.

We are expecting research outcomes with local characteristics, and make significant contributions in local technology services and talent development.





spectroscopy technology service network with local characteristics, realizing the overall project goal of "Photonics Cluster in the Southern Taiwan".







The ultimate goal of the project is to establish a photonics community in Southern Taiwan, centered around participating local research teams, with a focus on "novel material growth" and "cutting-edge spectroscopy measurements".







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