Real-Time Semiconductor Process Monitoring Breakthrough: Chih-Hsin Chen’s Team Wins the 22nd National Innovation Award

Campus focus

The research team led by Professor Chih-Hsin Chen of the Department of Chemistry was awarded the 22nd National Innovation Award in the Environmental Technology and Energy Applications category (Academic Research Innovation Award) on December 19, 2025, for its project titled “Real-Time Monitoring System for Gaseous Molecular Contaminants in Semiconductor Manufacturing Processes.” The award is organized by the Institute for Biotechnology and Medicine Industry (IBMI) and is a benchmark innovation award in Taiwan’s biomedical and health-related fields, aiming to encourage forward-looking technological R&D and innovative applications. Tamkang University’s Research and Development Office actively encourages patent-based startup teams with technology transfer potential to participate in such exhibitions to increase visibility and expand opportunities for industry–academia collaboration and technology commercialization.

Prof. Chen expressed gratitude for the University’s support of innovation and entrepreneurship, stating, “I am delighted to represent Tamkang University in this competition and to explore the startup pathway together with our students. This award not only recognizes our team’s cross-disciplinary integration results but also helps accelerate connections with industry and investors. Going forward, we will continue to strengthen system reliability and mass-production design, enabling this critical monitoring technology to take root domestically, improve semiconductor yield, reduce risks, and enhance supply-chain resilience.” Dean of Research and Development Po-Shen Pan also encouraged faculty and students to pursue patent development while actively considering links to industrial innovation, creating win–win outcomes for academia and industry.

Semiconductor manufacturing processes are extremely sensitive to gaseous molecular contaminants, particularly trace amounts of ammonia (NH_3), which can affect process stability and chip yield. However, commonly used tape-based monitoring equipment is bulky and costly, limiting deployment scale and flexibility. Chen noted that through industry engagement, the team identified an urgent need for an alternative solution that combines high sensitivity, low cost, and scalability to meet real-time monitoring requirements at the ppb level.

The award-winning team, comprising postdoctoral researchers Tsung-Yang Ho and Chih-Wei Huang, along with current students from the Department of Chemistry, focuses on real-time detection of trace ammonia. The system integrates highly specific colorimetric test strips, an embedded optical readout module, and algorithmic analysis to convert color changes into real-time concentration data. Compared with commercially available systems that rely on imported consumables, are limited to ppm-level detection, and incur high maintenance and expansion costs, this system enables in-house fabrication of high-sensitivity test strips and adopts a modular design, lowering adoption barriers while enhancing deployment flexibility and monitoring resolution.

In developing the dyes for the specific colorimetric test strips, the team approached the problem at the molecular level, leveraging collision-induced structural changes between substances that alter electron density distribution and energy gaps, thereby producing color responses. The core objective is to design test-strip materials that react with high selectivity to specific gaseous contaminants in semiconductor processes at extremely low concentrations, and exhibit pronounced color changes, serving as the key sensing element of the real-time monitoring system.

To date, the team has completed dye formulation design, algorithm validation, and prototype construction, and is collaborating with semiconductor equipment manufacturers and sensing application partners for testing and evaluation, advancing toward commercialization and domestic substitution. In the future, by modifying test-strip formulations, the system will be extended to detect other corrosive or toxic gases (such as PH_3 and AsH_3), to build a multi-point, distributed intelligent gas monitoring platform.