

## Key Research Achievements

### 1. Discovery of hydrogen etching anisotropy on diamond surfaces

- Revealed highly anisotropic etching behaviors of H atoms on both bulk and nanoscale diamonds, advancing the understanding of diamond surface chemistry.
- Published in *Physical Review Letters* (1997); laid the groundwork for identifying nanodiamonds in space via infrared spectroscopy.
- Recognized with *AS Research Award for Junior Researchers* (1998).

### 2. Identification of two distinct proton structures in water clusters

- Experimentally confirmed two stable forms of protons in protonated water clusters:  $\text{H}_3\text{O}^+$  (Eigen) and  $\text{H}_5\text{O}_2^+$  (Zundel).
- Published in *Journal of the American Chemical Society* (2000); resolved a decades-long debate in water cluster chemistry.
- Recognized with *NSC Outstanding Research Award* (2003).

### 3. Weighing single viruses and whole cells

- Built the world's first particle mass spectrometer for single viruses and intact cells, surpassing previous detection limits by orders of magnitude.
- Published in *Angewandte Chemie International Edition* (2006); featured by *Angewandte Chemie* ("Weighty Viruses"), *C&EN News*, and *New Scientist*. [\[LINK\]](#)
- Recognized with *Outstanding Scholar Award of Foundation for the Advancement of Outstanding Scholarship* (2007) and *MOE Academic Award* (2008).

### 4. Pioneering fluorescent nanodiamond (FND) technologies

- Invented bright, photostable, biocompatible FND probes with nitrogen-vacancy (NV) centers for bioimaging and quantum sensing; achieved the first gram-scale FND production.
- Published in *Journal of the American Chemical Society* (2005), *Proceedings of the National Academy of Sciences of the United States of America* (2007), and *Nature Nanotechnology* (2008); all highly cited.
- Recognized by U.S. National Institutes of Health (NIH) through a Small Business Innovation Research (SBIR) program in 2012 for scalable production of FNDs. [\[LINK\]](#)
- Honored with *Ho Chin Tui Award* (2014) and *MOST Outstanding Research Award* (2015).

### 5. Non-toxic, long-term stem cell tracking with FNDs

- Demonstrated ultra-low toxicity of FNDs in *C. elegans* and enabled long-term *in vivo* stem cell tracking at single-cell resolution.
- Published in *Nano Letters* (2010) and *Nature Nanotechnology* (2013); catalyzed collaboration with French partners under EuroNanoMed III.
- Positioned FNDs as leading nanomaterials for drug delivery and theranostics by **Sigma-Aldrich**. [\[LINK\]](#)
- Honored with *The Franco-Taiwanese Scientific Grand Prize* (2019), together with Francois Treussart at ENS Paris-Saclay, and *TNS Outstanding Research Award* (2020).

### 6. Super-resolution imaging and quantum sensing using FNDs

- Applied FNDs with NV centers as built-in fluorophores for super-resolution fluorescence imaging and nanoscale temperature sensing in living cells.
- Authored a review article in *Accounts of Chemical Research* (2016); positioned FNDs with high-density NV<sup>-</sup> centers as premier nanoscale quantum sensors.
- Adopted by Japan's Quantum Leap Flagship Program (**MEXT Q-LEAP**), launched in 2018, to further develop this cutting-edge technology. [\[LINK\]](#)
- Honored with *Far Eastern Y. Z. Hsu Chair Professor* (2017) and *CSLT Academic Achievement Award* (2021).

## 7. Spin-enhanced immunoassay platforms for healthcare diagnostics

- Pioneered spin-enhanced lateral flow immunoassays using FND quantum reporters; developed prototypes for clinical deployment.
- Published in *Analytical Chemistry* (2021); validated for detecting SARS-CoV-2, Dengue virus, C-reactive protein, and tuberculosis, etc.
- Included as a core flagship project in the UK Quantum Biomedical Sensing Research Hub (**Q-BIOMED**), launched in 2024, to advance this innovative technology. [\[LINK\]](#)
- Received *NSTC Distinguished Research Fellow* (2024).

## 8. Sensing and imaging extreme ultraviolet (EUV) radiation

- Created FND scintillation films as EUV detectors with exceptional sensitivity and radiation hardness for real-time beam diagnostics in EUV lithography.
- Published in *Nano Letters* (2023); captured the first real-time, high-resolution images of EUV beams at the National Synchrotron Radiation Research Center (NSRRC).
- Established collaborations with Jean-Francois Roch at ENS Paris-Saclay and the SOLEIL synchrotron in France.
- Received *NSTC FutureTech Award* (2023).

## 9. Integrating FND quantum sensors into working semiconductor devices

- Bridged the gap between quantum sensing and real-world electronics; contributed to enhancing Taiwan's global competitiveness in advanced semiconductor and quantum technologies.
- Published in *Advanced Functional Materials* (2025); established a novel platform for in operando diagnostics of semiconductor devices at the nanoscale.

## 10. Identification of nanodiamonds in space

- Provided compelling experimental evidence for nanodiamond dust in space via far-UV-excited luminescence from FNDs.
- Published in *Angewandte Chemie International Edition* (2017); highlighted their astrochemical significance and inspired EUV sensing applications.

## Patents and Technology Transfer

- Coined the term “fluorescent nanodiamond (FND)”, establishing it as the standard terminology in the field.
- Granted 5 U.S. patents and 5 ROC patents related to diamond-based innovations, including the

first U.S. patent on *Luminescent Diamond Particles* (2012).

- Transferred FND technologies to **FND Biotech**, a startup company founded by a team member in 2016, promoting research commercialization and real-world applications. [\[LINK\]](#)
- Adopted and commercialized by **Sigma-Aldrich**, demonstrating strong market value and commercial potential of FND technologies. [\[LINK\]](#)
- Filed multiple international provisional patents for *Extreme Ultraviolet or Soft X-ray Radiation Beam Profiler*, strengthening intellectual property protection and strategic positioning in key markets.
- Advanced diamond-based EUV imaging systems to Technology Readiness Level (TRL) 7, validated in synchrotron research environments, confirming readiness for market deployment.
- Designated by Academia Sinica for trade secret protection, underscoring the high commercial sensitivity and strategic value of FND technologies.