Nanotechnology **36** (2025) 060201 (3pp) https://doi.org/10.1088/1361-6528/ad4ebb

Editorial

Focus on Institute of Applied Physics at Seoul National University

by Guest Editors

Takhee Lee[1,*],
Kookrin Char[1,*]
and Gwan-Hyoung Lee[2,*]

[1] *Department of Physics and Astronomy, and Institute of Applied Physics, Seoul National University, Seoul 08826, Republic of Korea*

[2] *Department of Materials Science and Engineering, and Institute of Applied Physics, Seoul National University, Seoul 08826, Republic of Korea*

E-mail: tlee@snu.ac.kr, kchar@snu.ac.kr and *gwanlee@snu.ac.kr*

In response to changes in applied physics research environment, the Institute of Applied Physics (IAP) (https://iap.snu.ac.kr/en) at Seoul National University, Korea, was established in June 2013 by upgrading the existing Condensed Matter Research Center into an independent research institute in the College of Natural Sciences at Seoul National University. The mission of the IAP is to facilitate multidisciplinary basic and applied research across a variety of disciplines and also to promote convergence programs as part of industry-academia collaboration. With the goal of becoming a global leading applied research institute, IAP pursues domestic and international academic collaborations, including researcher exchange and diversified academic activities.

IAP focuses on four major research topics (quantum materials and devices, low-dimensional nanophysics, quantum photonics and display, and single-molecule biophysics) and provides five central laboratory facilities (cleanroom, low temperature, sample preparation, materials analysis, and bio-sample preparation facilities). A large number of principal investigators (currently, 41 professors) and researchers from a variety of disciplines including physics, chemistry, materials science, and electrical engineering participate in research projects at IAP.

Detailed descriptions of the main research topics in IAP are as follows.

Quantum materials and devices research: In condensed matter systems with appreciable electron-electron correlations or ultra-small dimensions, novel quantum phenomena that are not expected in ordinary materials may occur. These exotic properties are important not only in terms of fundamental science but also for future device applications. Examples of research topics include topological effects, unconventional superconductivity, quantum magnetism, and spin/orbital physics in two-dimensional (2D) materials, thin films, quantum dots, and quantum wells. Researchers in this group are devoted to developing quantum device technologies via comprehensive understanding of the quantum phenomena observed in quantum materials.

Low-dimensional nanophysics research: Nanophysics research explores various physical properties of the nanomaterials or nanostructures, aiming to understand newly observed nanoscale phenomena going beyond the scope of classical physics by integrating diverse disciplines, such as chemistry, biology, optics, material engineering, electrical engineering, and others. Researchers in this group synthesize low-dimensional nanomaterials (such as graphene, 2D materials, and topological materials) and fabricate nanostructured devices using various candidates such as compound semiconductors, oxide semiconductors, carbon materials, atomic-layered nanomaterials, topological Weyl materials, and molecular and organic materials, in order to explore new physical phenomena in these nanoscale materials and intricate structures and search for their novel applications in advanced electronics and optoelectronics.

[*] Authors to whom any correspondence should be addressed.

Quantum photonics and display research: This research focuses on several fields which include quantum optics, atomic physics, quantum information science, and optical display. Quantum optics and chaos studies high intensity quantum light, single photon generation, atomic optics, and quantum chaos using micro-resonators. Atomic physics and nanofluids investigates quantum phenomena of laser-cooled atoms, Bose–Einstein condensation, and molecular clusters and fluids. Quantum information science explores quantum entanglement, quantum nonlocality, and implementation of quantum information processing, such as quantum computer and quantum communication. Moreover, this research group further expands its scope to achieve a comprehensive understanding of light and to advance the performance of current optical devices and displays through the utilization of newly developed optical technologies and devices.

Single-molecule biophysics research: Biophysics is a research field that aims to quantitatively understand the fundamentals of the phenomena of life, which is clearly distinct from inanimate phenomena, by using statistical mechanics, computational physics, nanoscience, and optical technology. The research scope ranges from the microscopic scale of single molecules to the systems-level phenomena occurring in living organisms. In addition, efforts are being made to develop molecular sensing and medical diagnostic/analysis technologies that can be applied to real life.

In order to lead the applied physics research, it is important to have the best experimental equipment and facilities. The IAP provides five central laboratory facilities categorized into cleanroom facility, low temperature facility, sample preparation facility, materials analysis facility, and bio-sample preparation facility. All equipment installed at IAP are available to IAP members and users, as well as to off-campus users at a reasonable cost needed for maintenance and repair of the equipment. The detailed list of the available equipment can be found on the IAP's website (https://iap.snu.ac.kr/en/equipment/list). The materials analysis facility was newly opened in January 2024 by inheriting the equipment of the Center for Correlated Electron Systems at Seoul National University, which had operated from 2012 to 2023 as one of the centers of the Institute for Basic Science (www.ibs.re.kr/eng.do). The Center for Correlated Electron Systems had been funded approximately 87 billion Korean Won (US $67 million) during its 12 year operation, which enabled installation of many state-of-art equipment.

IAP's staff members are responsible for administrative support and maintenance of the facilities, and the Steering and Advisory Committee of IAP provides review and guidance on executive issues. IAP's faculty members participate in research projects worth an average of ∼16 billion Korean Won (US $12 million) per year under contracts with Korean research funding agencies and international organizations. IAP will continue to strive for enhancing Korea's international competitiveness through technology-transferring its outstanding research outcomes and nurturing the future global talents. As a recent example of industry-academia cooperation, a joint workshop took place between IAP and the Samsung Advanced Institute of Technology (www.sait.samsung.co.kr/) in July 2023, providing an opportunity for networking and cooperation between academia and industry.

This collection contains review articles and new research articles on the aforementioned IAP's research topics. Specifically, a review written by Gwan-Hyoun Lee's group focused on representative in-plane anisotropic 2D materials and their properties, as well as twistronics using in-plane anisotropic 2D materials [1]. And two reviews written by Byung Hee Hong's group summarize synthesis, properties, and application of 2D materials or graphene quantum dots [2, 3]. And, this collection also contains six new research articles. Gyu-Chul Yi's group reported the growth of single-crystalline GaN microdisk arrays on graphene and their application in flexible light-emitting diodes [4]. Changyoung

Kim's group established $LaCoO_3$ thin film, a ferromagnetic insulator, as a robust platform to impose magnetic proximity effect on target layers, with a potential application in spintronics and various electronic devices [5]. Hong-Gyu Park's group demonstrated the enhancement of second-harmonic generation in a heterobilayer consisting of WSe_2 and WS_2 monolayers stacked at a certain twist angle of 64.1° [6]. Jihyun Kim's group systematically investigated a wet cleaning method for Ta-based extreme ultraviolet photomasks [7]. Ki Tae Nam's group demonstrated circular polarization sensitive opto-neuromorphic operation at hot electron transistor using chiral plasmonic gold nanoparticles [8]. And Takhee Lee's group studied high-energy proton beam irradiation effects on the electrical properties of field-effect transistors made with tungsten diselenide (WSe_2) channels and hexagonal boron-nitride (hBN)/SiO_2 gate dielectrics [9].

Data availability statement

No new data were created or analysed in this study.

ORCID iDs

Takhee Lee https://orcid.org/0000-0001-5988-5219
Gwan-Hyoung Lee https://orcid.org/0000-0002-3028-867X

References

[1] Kim H, Kim C, Jung Y, Kim N, Son J and Lee G-H 2024 In-plane anisotropic two-dimensional materials for twistronics *Nanotechnology* **35** 262501
[2] Lee Y, Hong S, Moon I, Kim C-J, Lee Y and Hong B H 2025 Laser-assisted synthesis and modification of 2D materials *Nanotechnology* **36** 052003
[3] Bae G, Cho H and Hong B H 2024 A review on synthesis, properties, and biomedical applications of graphene quantum dots (GQDs) *Nanotechnology* **35** 372001
[4] Fabunmi T G *et al* 2024 Single-crystalline GaN microdisk arrays grown on graphene for flexible micro-LED application *Nanotechnology* **35** 085603
[5] Lee Y, Kim Y, Lee S and Kim C 2024 Ferromagnetic insulating substrate for magnetic proximity studies: $laCoO_3$ thin film *Nanotechnology* **35** 125001
[6] Chang S, Lee H-C, Na G, Kim R M, Moon Y-J, Kim H-R, Nam K T and Park H-G 2024 Enhancement of second-harmonic generation in a 64° stacked WSe_2/WS_2 heterobilayer with local strain *Nanotechnology* **35** 145201
[7] Park J, Choi W and Kim J 2024 Wet cleaning of Ta-based extreme ultraviolet photomasks at room temperature *Nanotechnology* **35** 205701
[8] Namgung S D, Kim R M, Han J H and Nam K T 2024 Circular polarization sensitive opto-neuromorphic operation at plasmonic hot electron transistor using chiral gold nanoparticles *Nanotechnology* **35** 245201
[9] Ko S, Shin J, Jang J, Woo J, Kim J, Park J, Yoo J, Zhou C, Cho K and Lee T 2024 Reduced interface effect of proton beam irradiation on the electrical properties of WSe_2/hBN field effect transistors *Nanotechnology* **35** 305201