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Department of Electronics & Communication Engineering

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Vision of the Institute

To be a nationally recognized institution of excellence in technical education and produce competent professionals capable of making a valuable contribution to society.

Mission of the Institute

- To promote academic growth by offering state-of-the-art undergraduate and postgraduate programs.
- To undertake collaborative projects which offer opportunities for interaction with academia and industry.
- To develop intellectually capable human potential who are creative, ethical and gifted leaders.

Vision of the Department

To produce globally competent electronics & communication engineering students with knowledge of core as well as inter-discipline domains.

Mission of the Department

- Educating the students in field of electronics and communication engineering to create competent professionals with moral values, social ethics and pursuing higher education.
- Inculcating the understanding technical competence in the fields of electronics and communication engineering and implementation of theoretical concepts in practical multidiscipline scenarios.

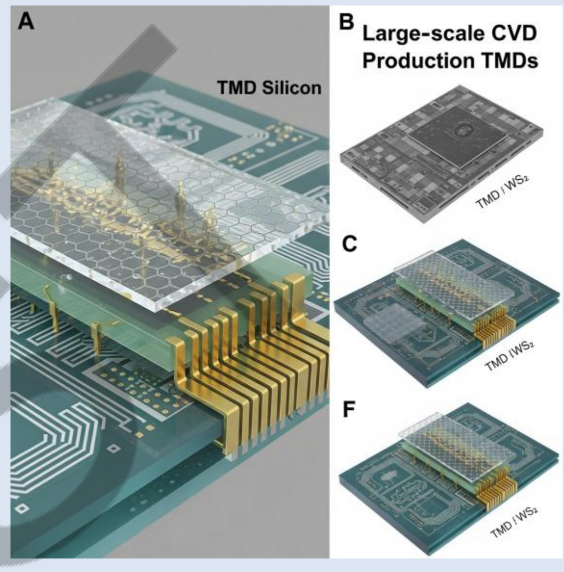
Message from the Head of Department

This issue spotlights the groundbreaking work on Transition Metal Dichalcogenides (TMDs), ushering in a new era for nanoelectronics beyond silicon. We explore their development, the unique hurdles and opportunities they present, and the cutting-edge trends positioning TMDs as a revolutionary force in materials science and electronics.

TMDs: Pioneering the Next Generation of Nanoelectronics

Transition Metal Dichalcogenides (TMDs) have emerged as one of the most promising materials in the field of nanoelectronics, offering unique properties that extend far beyond the limits of traditional silicon-based technology. With their atomically thin structure, tunable band gaps, and excellent electrical and optical characteristics, TMDs such as molybdenum disulfide (MoS_2) and tungsten diselenide (WSe_2) are redefining how electronic devices can be designed and operated. Their ability to combine high performance with flexibility and transparency makes them ideal for applications in transistors, sensors, photodetectors, and flexible displays. As industries move toward miniaturization, low-power consumption, and multifunctionality, TMDs stand at the forefront of innovation, paving the way for smarter, faster, and more sustainable electronic systems.

TMDs News Highlights



- Researchers at MIT demonstrated TMD-based transistors operating at room temperature with remarkable on/off switching performance, moving closer to practical post-silicon devices.
- Samsung announced a prototype flexible display powered by MOS_2 transistors, highlighting the role of TMDs in consumer electronics.
- Scientists in India developed WS_2-based biosensors capable of detecting glucose levels with high precision, pointing toward healthcare applications.
- A European research consortium initiated large-scale CVD (Chemical Vapor Deposition) projects to enable mass production of high-quality TMD monolayers for industry use.
- The University of Tokyo reported advances in TMD–silicon hybrid devices, combining the scalability of silicon with the flexibility of 2D materials.

TMD Development: Revolutionizing Electronics beyond Silicon

Transition Metal Dichalcogenides (TMDs) are emerging as a breakthrough class of two-dimensional (2D) materials poised to redefine the future of electronics. With the general formula MX_2, where M is a transition metal (such as molybdenum or tungsten) and X is a chalcogen (sulfur, selenium, or tellurium), TMDs combine unique properties such as tunable band gaps, high carrier mobility, mechanical flexibility, and atomic-scale thickness. Unlike graphene, which lacks a natural band gap, TMDs can be engineered for semiconductor applications, making them a promising candidate for post-silicon nanoelectronics.

In the electronics domain, TMDs are enabling the design of ultra-thin field-effect transistors (FETs), flexible circuits, and transparent devices that can seamlessly integrate with wearables and bendable displays. Their strong light–matter interactions are fueling applications in optoelectronics, including photodetectors, LEDs, and solar cells. Furthermore, TMD-based nanosensors are gaining attention in environmental monitoring and biomedical diagnostics due to their high sensitivity at the atomic scale. A major advantage of TMDs lies in their compatibility with flexible and low-power electronics, making them vital for next-generation technologies such as wearable systems, Internet of Things (IoT) devices, and smart healthcare platforms. As the global demand for miniaturized and multifunctional devices grows, TMDs hold the potential to bridge the gap between high performance and sustainable, lightweight solutions.

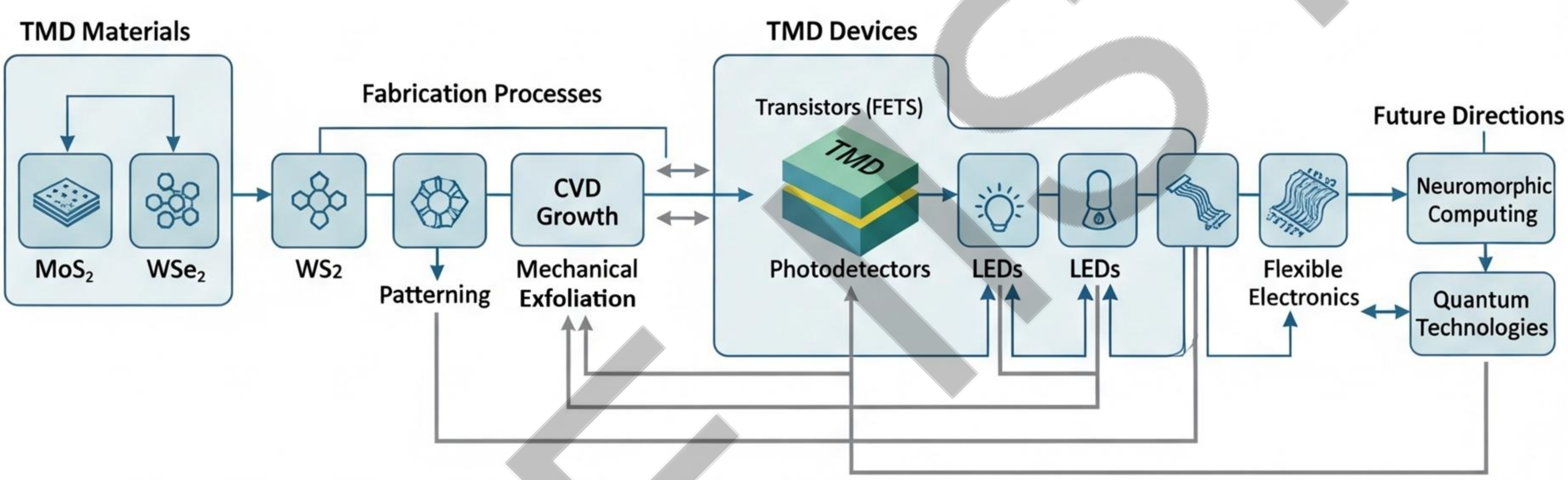
Challenges and Opportunities in TMDs

TMDs open unprecedented opportunities across electronics and communication engineering. Their potential spans high-speed nanoelectronics, optoelectronic systems, flexible and wearable devices, smart sensors, and energy-efficient communication technologies. However, several challenges accompany their promise.

On the opportunity front, TMDs bring atomic-scale thickness, mechanical flexibility, and tunable band gaps that make them highly suitable for next-generation transistors, low-power IoT devices, and lightweight, bendable displays. Their strong interaction with light also positions them as a key enabler in solar energy harvesting, photonic devices, and 5G/6G communication systems. With biosensing capabilities, TMDs can integrate into point-of-care healthcare solutions and advanced diagnostic systems.

Despite these opportunities, challenges remain in realizing large-scale commercial adoption. Producing defect-free, uniform monolayers at industrial scale is technically complex and costly. Integration with existing silicon-based manufacturing requires new fabrication techniques and standards. Stability under environmental conditions such as humidity and temperature also poses hurdles, limiting device lifetime. Additionally, the high cost of synthesis and lack of standardized processes restricts widespread deployment in commercial electronics.

Balancing these challenges with innovation can unlock the full potential of TMDs. Investments in scalable fabrication, cross-disciplinary collaboration, and development of hybrid architectures will be crucial. With focused research, TMDs can become a cornerstone of sustainable, high-performance electronics, shaping the next era of nano- and optoelectronic technologies.



Emerging Trends in TMD Research

Transition Metal Dichalcogenides (TMDs) are gaining significant attention due to their unique two-dimensional (2D) layered structure, tunable bandgap, and exceptional electronic, optical, and mechanical properties. Recent research trends highlight their potential in nanoelectronics, optoelectronics, sensing, spintronics, and flexible electronics. One of the major directions is the scalable synthesis of high-quality monolayers using techniques such as chemical vapor deposition (CVD) and molecular beam epitaxy (MBE), which aim to improve uniformity and defect control. Another emerging area is the heterostructure engineering of TMDs, where stacking with other 2D materials like graphene or hexagonal boron nitride enables novel device architectures for high-performance transistors, photodetectors, and quantum devices.

Moreover, strain engineering and doping strategies are being extensively explored to tune the electronic and optical properties of TMDs for customized applications. The integration of TMDs into neuromorphic computing, quantum information systems and energy harvesting devices is also expanding. Additionally, TMD-based field-effect transistors (FETs) are being considered as candidates to replace silicon in next-generation nanoelectronics, while their superior sensitivity to surface adsorbates makes them highly suitable for biosensing and environmental monitoring. With continuous progress in material synthesis, device integration, and theoretical modeling, TMDs are poised to play a pivotal role in shaping the future of advanced electronic and photonic systems.

> ***"Transition Metal Dichalcogenides bridge the gap between silicon and the future of electronics, offering atomic-scale control with extraordinary versatility. Their unique properties make them the cornerstone for next-generation nanoelectronics and quantum devices."***

Lastly, TMDs are paving the way for eco-friendly and sustainable electronics. Their thinness reduces material consumption, while advances in green synthesis methods support environmentally responsible production. As research accelerates, the combination of tunability, flexibility, and scalability makes TMDs one of the most exciting frontiers in electronics and communication engineering, with potential to transform industries ranging from consumer electronics and healthcare to energy and communication networks.

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