

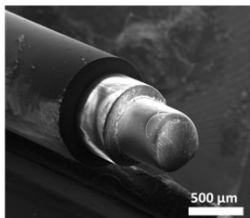
Fiber-Based Nanogenerators for Advanced Wearable Technologies

Mustafa Ordu

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The rapid growth of wearable technologies drives demand for real-time, battery-independent monitoring of human activities and physiological signals. Flexible piezoelectric and triboelectric nanogenerators offer a compelling solution by acting as self-powered sensors that function without external power supplies. These devices also enable energy harvesting from everyday human motion, presenting a viable alternative energy source for low-power electronics. Among them, fiber-shaped nanogenerators stand out due to their inherent flexibility, stretchability, and compatibility with textile manufacturing, allowing direct integration into wearable fabrics. This talk will present our research activities on the development of thermally drawn, fiber-based triboelectric and piezoelectric nanogenerators, highlighting their dual role as both self-powered sensors and energy harvesters. By incorporating low-dimensional materials into thermally drawn fibers, the sensing and energy conversion performances of nanogenerators are significantly enhanced. Moreover, forming highly porous media and micro/nano spheres in fibers further controls the electrical properties that can be exploited for multifunctional sensing. These smart fibers demonstrate promising capabilities for tracking physical human activities and vital signs such as heart rate, respiration, and blood pressure. Furthermore, their ability to convert mechanical energy into electricity opens pathways for powering small-scale and portable electronic devices, without the need for traditional batteries.

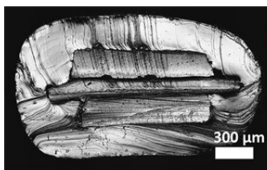
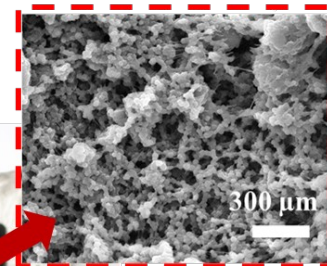
Triboelectric nanogenerators



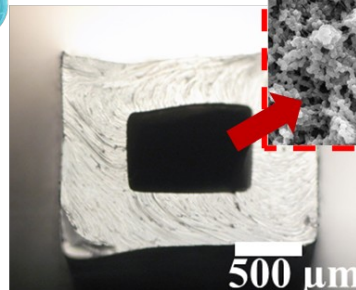
Magnetic fibers



Piezoresistive fibers



Piezoelectric nanogenerators



New Generation Nano-electronic Devices Based on 2D Materials

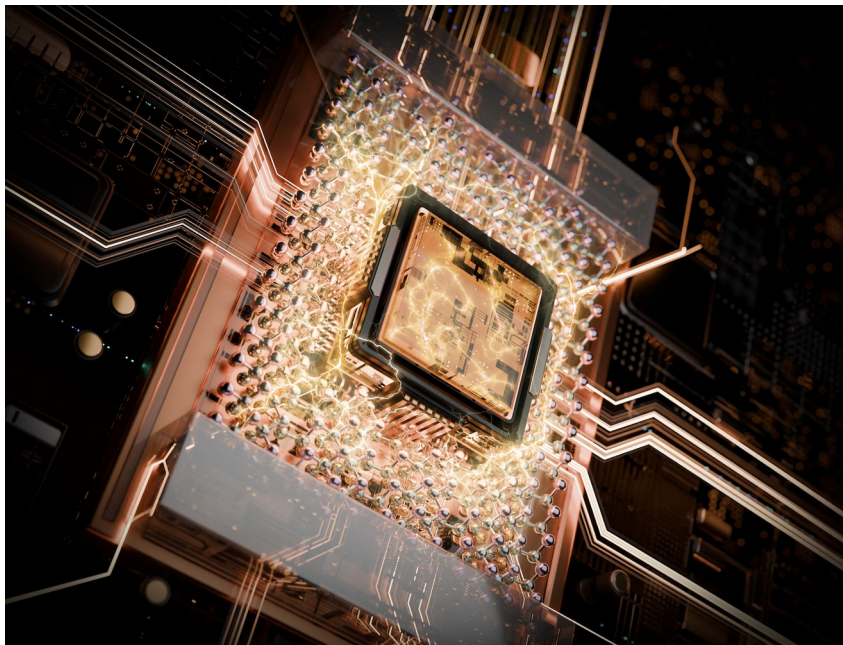
Engin Durgun

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As conventional semiconductor technologies approach their fundamental limits, two-dimensional (2D) materials are emerging as a powerful platform for redefining the future of electronics. With their atomically thin nature and highly tunable properties, these materials offer remarkable opportunities to design devices that are not only smaller, but also faster and more energy-efficient than ever before.

In this talk, I will present our efforts to uncover and harness the potential of 2D materials for next-generation nano-electronic applications. By combining state-of-the-art computational methods with device-level modeling, we explore how quantum mechanical effects govern electron transport at the ultimate scaling limits. Our work reveals how subtle changes in structure, composition, and external conditions can be leveraged to engineer electronic behavior with remarkable precision. We focus on key building blocks of future technologies, including metal–semiconductor (Schottky) interfaces, p–n junctions (diodes), and ultra-scaled transistor (MOSFET) architectures, highlighting pathways toward high-performance and low-power device operation. Beyond understanding, this research aims to establish design principles that can guide the realization of novel electronic systems.

Rather than focusing solely on theory, this work aims to bridge the gap between fundamental understanding and practical device design. The insights gained from these studies provide guidance for developing faster, smaller, and more energy-efficient electronic technologies based on emerging 2D materials.





Dr. Mustafa Ordu is an assistant professor at UNAM-National Nanotechnology Research Center and Institute of Materials Science and Nanotechnology at Bilkent University, Türkiye. He received his B.S. and M.S. in Mechanical Engineering from Istanbul Technical University, Türkiye and Tohoku University, Japan, respectively, and earned his Ph.D. from Boston University in 2018. He was a postdoctoral researcher on the development of hollow-core optical fibers at the XLIM Research Institute in Limoges, France before joining Bilkent. His research interest covers a variety of sensor fibers, such as piezoelectric, triboelectric and porous nanocomposite fibers and optical fibers, including hollow-core fibers, semiconductor-core fibers

and microstructured polymer fibers. Dr. Ordu is the author of the book titled “Nanogenerators: Energy Harvesters and Self-Powered Sensors” published by Royal Society of Chemistry in 2025. He is the recipient of Ten Outstanding Young Person Prize (TOYP) by JCI Türkiye and METU Parlar Foundation Research Incentive Award.

Autobiography – Engin Durgun

Dr. Engin Durgun got his PhD (2007) degrees from Department of Physics, Bilkent University. After graduation he moved University of Liege (Belgium) for post-doctoral studies, and then worked at Materials Science and Engineering, Massachusetts Institute of Technology (MIT) for three years as a post-doctoral associate. He returned to Turkey in 2013 and joined UNAM - Institute of Materials Science and Nanotechnology, Bilkent University as a faculty member. He currently serves as the deputy director of UNAM and is an associate member of Turkish Academy of Science.

Dr. Durgun is working in the multidisciplinary field of computational science, which intersects physics, chemistry, materials science and engineering. He applies advanced computational simulation methods to address critical challenges in various areas including nanotechnology, clean and sustainable energy and environment. He works in collaboration with both experimental and theory colleagues and also conducts joint projects both in Europe and USA. Currently, he is working on investigation and application of 2-dimensional materials, which is a promising field following the realization graphene. Dr. Durgun is a reviewer of national and international projects and a member of American Physical Society (APS), Materials Research Society (MRS), and American Chemical Society.

Dr. Durgun has more than 120 publications in SCI journals and received more than 10000 citations. The research findings have been presented in various national and international conferences as invited and contributed talks. He is the recipient of many prestigious awards including Incentive Award from the Scientific and Technical Research Council of Turkey (TUBITAK 2018), Ten Outstanding Your Persons of the World in the field of Scientific Leadership (JCI-Junior Chamber International, 2017), Ten Outstanding Your Persons of Turkey in the field of Scientific Leadership (JCI-Junior Chamber International, 2016), Young Scientist of the Year (Heroes of Science Association, 2015), Eser Tümen Young Scientist Award (FABED, 2015), Young Scientist Award of the Turkish Academy of Sciences (TÜBA-GEBİP, 2015), Research Incentive Award (METU Prof. Dr. Mustafa Parlar Foundation, 2015) and Young Scientist Awards of the Science Academy (BAGEP, 2013).

Autobiography – Haris Dapo

Based on my significant experience in nuclear physics, my expertise lies in both experimental and theoretical nuclear physics. My career has focused on the practical application of this knowledge, with a strong background in photonuclear reactions using clinical linear accelerators. On the experimental side, most of my work has been focused on determining the energy transitions and half-lives of various isotopes.

In my role at the Turkish Accelerator & Radiation Laboratory (TARLA), I have significant responsibilities in the design and construction of nuclear experimental stations. This involves extensive Monte Carlo simulations using FLUKA to model and optimize the station layouts. Furthermore, I am also responsible for radiation safety within the facility, utilizing these same Monte Carlo methods for design and redesign to ensure a safe and secure environment.

In addition to this experimental work, my research also encompasses heavy-ion-induced reactions and their role in fundamental physics, particularly as part of the NUMEN collaboration, where we study neutrinoless double beta decay. My theoretical contributions include work on nuclear energy density functional and the study of hyperons in neutron stars, which provides a comprehensive understanding of nuclear matter under extreme conditions.

Throughout my career, I have held roles as an Assistant Professor and Senior Researcher. My experience also includes contributing to the construction of a new accelerator laboratory in Sarajevo. I am an active participant in several international collaborations, including those at CERN and INFN.