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Introduction to the *Nanoscale* and *Nanoscale Advances* joint themed collection: Synthesis, physical properties and applications of advanced nanocrystalline materials

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This themed collection in *Nanoscale* and *Nanoscale Advances* highlights recent progress in advanced nanocrystalline materials, focusing on synthesis, physical properties, and applications. The collection opens with a review article by Xiao Wang *et al.*, summarizing recent progress in structural engineering of noble metal-based nanozymes and their diverse biomedical applications (**https://doi.org/10.1039/D4NR05514D**). Yun Fan and Mengyun Chen review the preparation and applications of chiral metal–organic framework (MOF) membranes (**https://doi.org/10.1039/D5NR00938C**). Tzu-Yi Lee *et al.* discuss advances in core technologies for semiconducting fabrication, atomic layer etching, atomic layer deposition, and neutral beam etching (**https://doi.org/10.1039/D4NA00784K**). Further, Anulipsa Priyadarshini *et al.* summarizes the advancements in metal–organic framework and covalent organic frameworks for energy harvesting by piezoelectric and triboelectric nanogenerators (**https://doi.org/10.1039/D4NR04570J**). Furthermore, Salih Veziroglu *et al.* review the recent progress in photocatalytic deposition of noble metals on 0D (NPs and nanocrystals), 1D (nanotubes and nanowires), and 2D (thin films) TiO_2 structures (**https://doi.org/10.1039/D4NA00623B**). Together, these reviews offer a comprehensive understanding of the most recent advancements and challenges in the field of advanced nanocrystalline materials, emphasizing the motivations for bridging the gap between laboratory research and real-world applications.

In addition to insightful review articles, this collection features original research papers that highlight key advances in nanomaterials and their applications. Mashael H. Albuqami *et al.* developed flexible textile triboelectric nanogenerators by electronically dyeing polyester with two-dimensional tungsten disulfide (2D WS_2), which improved the triboelectric properties when combined with nylon (**https://doi.org/10.1039/D4NR05209A**). Their findings underscore the potential of 2D WS_2-based triboelectric nanogenerators for wearable and flexible technologies, offering a strong basis for self-powered sensing and energy-harvesting applications. Francesco Bisconti *et al.* reported their findings on the inclusion of polysaccharides in perovskite thin films (**https://doi.org/10.1039/D4NA01036A**). The results of this study demonstrate hydroxyethyl cellulose's potential as an intrinsic stabilizer for perovskite films, opening the door to more durable and scalable perovskite solar cell technologies. Gourab De *et al.* investigated the role of in-plane stress behavior on ferroelectric properties of scaled-up hafnium zirconium oxide superlattices (**https://doi.org/10.1039/D4NR05053C**). This work suggested that it is possible to scale up these superlattices while preserving identical ferroelectric properties by tuning the in-plane stress of the hafnium zirconium oxide layers and their interfaces. A. Nicolás Filippin *et al.* described a reproducible and economically viable method for creating organic nanowires (ONWs) and nanotrees (ONTs) as light-enhanced conductometric O_2 sensors (**https://doi.org/10.1039/D4NR04761C**), paving the way for the development of long-lasting gas sensors operating at room temperature. The thin film growth of $[Ni(Hvanox)_2]$ was reported by Atharva U. Sapre *et al.* using spectroscopic and microscopic characterizations (**https://doi.org/10.1039/D4NA01021C**). Surajit Das *et al.* reported piezoelectric and piezophototronic properties of LN-type $ZnSnS_3$ nanocrystals for light-induced self-powered mechanical energy harvesting (**https://doi.org/10.1039/D4NR05246C**). By combining optical functionalities and piezoelectric responses, these findings establish ternary sulfide piezoelectric nanostructured material as a viable

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option for designing piezophototronic devices. Superparamagnetic nanoparticles were described by Maria L. Schumacher *et al.* as possible drug delivery vehicles for the treatment of Duchenne muscular dystrophy (**https://doi.org/10.1039/D4NR03407D**). Olena Porodko *et al.* demonstrated the electrochemical performance of new lithiated high-entropy spinel-type oxyhalides in Li-ion batteries (**https://doi.org/10.1039/D4NR03918A**). Siyun Noh *et al.* presented research on a self-powered triboelectric sensor that uses stress concentration structure and GaN nanowires (**https://doi.org/10.1039/D4NR03260H**). According to Apoko S. Omondi *et al.*, symmetry breaking affects the core/shell tetrametallic porous nanoparticles' catalytic and electrocatalytic performance (**https://doi.org/10.1039/D4NR03589E**). High-quality Cu_2ZnSnS_4 nanoparticles were created by Amin Hasan Husien *et al.* using HCl purification and opti-

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Aurora Rizzo is a senior researcher at the Nanotechnology Institute NANOTEC-CNR in Lecce, Italy. She earned her PhD in materials and innovative technologies in 2008, with a thesis titled "Hybrid Colloidal Nanocrystal Organic Based LEDs". From 2008 to 2009, she worked with the biomolecular and organic electronics group led by Prof. Inganäs at Linköping University, Sweden, focusing on "Bio-Organic Light Emitting Diodes". In 2010, she founded the Hybrid and Organic Photovoltaics (HOPV) Lab at CNR-Nanotec in Lecce, which she currently leads. Since then, she has served as a principal investigator or scientific lead for CNR-Nanotec in numerous funded projects. Rizzo has authored over 100 peer-reviewed articles in international scientific journals, holds three patents, and has contributed to two book chapters. Her research interests center on the development of hybrid organic/inorganic materials, with a focus on metal halide perovskite polycrystalline/single crystal materials and perovskite polymer composites for advanced optoelectronic and photonic applications.

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Ermelinda Maçôas is a principal researcher at Centro de Química Estrutural, University of Lisbon, and an assistant professor at the Instituto Superior Técnico. She earned her PhD in chemistry from the University of Coimbra, Portugal, specializing in molecular spectroscopy and advanced optical microscopy. Her previous roles include senior researcher at the Nanoscience Center, University of Jyväskyla (Marie Skłodowska-Curie fellowship, 2006–2007), Department of Chemistry, University of Coimbra (2008), and Institute of Nanoscience and Nanotechnology, Lisbon (2009–2018). Her research focuses on optically responsive molecular materials, with an emphasis on emissive nonlinear materials and organic semiconductors. Currently, she explores carbon nanomaterials for applications in imaging, therapy, and sensing using nonlinear fluorescence techniques. Her methodologies include steady-state and time-resolved optical spectroscopy, fluorescence microscopy, and electronic-structure computations.

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mized hot injection (**https://doi.org/10.1039/D4NA00843J**). Stretchable photosensors that function within the 1.3 μm wavelength range were created by Jaehyeok Shin *et al.* using graphene and InN nanowires (NWs) as a carrier channel and light-absorbing medium, respectively (**https://doi.org/10.1039/D4NR03257H**). According to Fei Yin *et al.*, surface nanoengineering can greatly enhance a metal's mechanical characteristics and performance, including their strength, hardness, fatigue resistance, and wear resistance (**https://doi.org/10.1039/D4NR02994A**). Using porous CuS@CdS@Au nanoshells, Weimin Yang *et al.* reported dual-mode detection for the overall antioxidant capacity of skincare products (**https://doi.org/10.1039/D4NR03313B**). This study offers a useful tool for quality control in the skincare sector in addition to enhancing the accuracy of antioxidant evaluations. Arvin Taghizadeh Tabrizi *et al.* reported the core/shell boron carbon nitrides (BCN)@Cu heterostructures for direct electrochemical reduction of nitrate ions to ammonia, which has a great promise for green ammonia synthesis (**https://doi.org/10.1039/D5NR02308D**).

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