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Editorial: Emerging leaders in nanotechnology

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Editorial on the Research Topic
Emerging leaders in nanotechnology

This Research Topic of *Frontiers in Nanotechnology* celebrates the achievements of emerging leaders driving innovation in the broad field of nanoscience and nanotechnology. The diverse articles in this Research Topic reflect the wide variety of Research Topic within nanoscience and nanotechnology. This Research Topic brings together contributions spanning fundamental and applied research, from two-dimensional materials and catalytic nanostructures to biotechnology and education in nanotechnology. Each research article, as well as the perspective article, showcases the work of young scientists who are shaping the future of the field by using sophisticated instruments and methods, introducing novel ideas, interdisciplinary approaches, and opening new scientific frontiers.

Diaz-Marcos and Mendoza Gonzalvez provide an overview of education and dissemination, stressing the need for an ethical approach to nanotechnology. The authors demonstrate that disseminating information about nanotechnology is challenging due to the general public's unfamiliarity with the terminology, particularly regarding the size of nanomaterials, which is compounded by the ambiguous portrayal of nanotechnology in the mass media. They recommend involving the public in nanotechnology by making specialized knowledge more accessible and informing them about its benefits and risks. They believe in starting with basic concepts and using advanced methods such as scanning electron microscopy (SEM) to visualize nanoparticles. Additionally, collaboration among scientists, teachers, and science communicators is beneficial for overcoming challenges in the dissemination of science. The authors also offer recommendations to enhance the societal perception of nanotechnology.

The study by Dan et al., explores the scalable production of high-quality two-dimensional transition metal dichalcogenide (TMD) monolayers, namely, WS_2 and WSe_2, using the kinetic *in situ* single-layer synthesis (KISS) method. The authors show the influence of different substrates (Au, Ag) and TMD chalcogen elements (S, Se) on the film quality and dimensions, with WSe_2 consistently yielding larger monolayers than WS_2, independent of substrate. Structural and chemical analyses confirmed high crystallinity and non-destructive exfoliation, without any covalent bonding to substrates. This work particularly highlights the use of the KISS method to obtain large high quality TMD monolayers which can be used in fundamental and applied research.

The Research Topic presents two papers examining the formation of a biomolecular corona on nanoparticles (NPs) upon exposure to the bloodstream or biological fluids. This phenomenon is crucial for understanding the potential applications of NPs in therapies and evaluating their safety. It involves the rapid adsorption of proteins, lipids, and sugars onto the particle surface, and studying its evolution over time is the focus of extensive experimental research. Theoretical work on adsorption kinetics and corona evolution is limited and often tied to simulation outcomes. The first paper on NP-corona formation presented here offers a theoretical perspective based on a simplified model, aiming to bridge this knowledge gap. Åberg and Jansen explore the kinetics of corona formation, the variability of corona composition across different particles, and the spatial distribution of various biomolecules within the corona. Their assumptions include irreversibility of adsorption and the lack of biomolecule-biomolecule interactions. They suggest this approach as a valuable reference for experiments and future theoretical investigations.

The second paper on NP-corona formation–by Clemente et al. is an original experimental study that aims to control the process for enhancing NP biocompatibility and extend circulation time by minimizing protein adsorption. To achieve this goal, surface modifications using polyethylene glycol (PEG) polymers are typically employed due to their steric hindrance and repulsion effects. However, continuous exposure to PEGylated NPs can trigger both acute and chronic immune responses, which limits their use in treating various conditions. The authors of this contribution suggest an alternative strategy using monosaccharide (glycans) coatings.

Glycans are biocompatible, interact with biological receptors in the body, and can be conjugated to control their orientation, which enhances NP stability in solution due to their hydrophilic nature. Specifically, they developed a series of gold NPs (AuNPs) that are coated with PEG linkers of varying lengths and conjugated with mannose (Man) or sialic acid (Sia) glycans, meticulously characterizing them before and after exposure to biological fluids. The results suggest that coating impacts the formation of the protein corona, but it does not affect the interaction with glycan receptors, even within a complex protein environment. Thus, glycan modification of PEGylated NPs minimizes nonspecific interactions while maintaining active targeting properties, highlighting their potential for therapeutic applications.

The paper authored by Czajkowski et al., focuses on a unique aspect of protein organization in cells: the formation of biomolecular condensates. These condensates can form spontaneously *in vivo* in response to external stresses or to fulfill essential biological functions. They consist of solvated RNA-binding proteins, often incorporating nucleic acids. In this study, the authors examine how post-translational modifications (PTMs) and salt concentration influence the protein Fused in Sarcoma (FUS) in terms of its tendency to form biomolecular condensates. They utilize two expression systems—bacterial and insect cells—that differ in their ability to incorporate PTMs into the protein, and they analyze the solvation of FUS condensates, both with and without PTMs, at 100 mM and 2.5 M KCl using attenuated total reflection Terahertz spectroscopy. The findings indicate that PTMs significantly affect the phase-separation propensity, whereas protein solvation within the condensate remains unaffected. Conversely, variations in salt concentration modify the stiffness of the water hydrogen bond network, causing perturbations in the molecular organization of the condensate due to changes in solvent properties.

The study by Sakinala et al., explores the development of Cu-supported doped-CeO_2 catalysts and their application in the oxidation of benzylamine, both in the absence and presence of 1,2-diaminobenzene. The authors show that the prepared CuO/CeO_2 -ZrO_2 catalyst offers a highly efficient, robust, and recyclable system for the selective oxidative coupling of benzylamines to imine (99.5%), benzimidazole (99.2%) and its derivatives under solvent-free conditions. The catalytic activity is influenced by the presence of oxygen vacancy sites, strong metal support interaction, enhanced redox behavior and a high density of acidic sites, which collectively contribute to its superior performance. This study highlights the importance and necessity for further studies on ceria-based catalysts in oxidative processes.

Together, these contributions illustrate the multifaceted nature of nanotechnology research, highlighting the work led by emerging scientists in the field. From innovative synthesis methods and theoretical insights to biocompatible nanomaterials and ethical considerations in education, this Research Topic highlights the creativity and interdisciplinary spirit driving the next-generation of discoveries in nanoscience and nanotechnology.

Author contributions

MG: Writing – review and editing, Writing – original draft. SB: Writing – original draft, Writing – review and editing. SM: Writing – original draft, Writing – review and editing. GF: Writing – review and editing, Writing – original draft.

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