



Introduction to nanozymes

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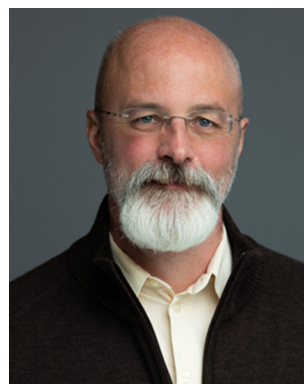
Nanozymes are nanomaterials with enzyme-like characteristics.¹ They have been employed to address the intrinsic limitations of enzymes and conventional artificial enzymes. In recent years, dramatically increasing research interest has been attracted to the field of nanozymes. This themed collection (*Nanozymes*)



Shaoqin Liu

Professor Shaoqin Liu is an Associate Editor for *Journal of Materials Chemistry B*. She received her Bachelor degree and PhD degree from Wuhan University of Hydraulic and Electric Engineering in 1994 and from Changchun Institute of Applied Chemistry (Chinese Academy of Science) in 1999, respectively. She started her chemistry research career in Professor Shaojun Dong's group at Changchun Institute of Applied

Chemistry to develop polyoxometalates-based thin film. After her PhD degree, she moved to the Max Planck Institute of Colloids and Interfaces as a Humboldt Fellow. She developed polyoxometalates-based functional materials. In 2004, she joined the National Research Council of Canada as an NESRC fellow to study direct methanol fuel cells. In 2007, she started her academic career as Full Professor at the Harbin Institute of Technology. Her current research interests include the preparation of nanostructured materials and their applications in energy, biosensing and cancer therapy.



Vincent Rotello

Vincent Rotello is the Charles A. Goessmann Professor of Chemistry and a University Distinguished Professor at the University of Massachusetts at Amherst. He received his BS in Chemistry in 1985 from Illinois Institute of Technology, and his PhD in Chemistry in 1990 from Yale University. He was an NSF postdoctoral fellow at Massachusetts Institute of Technology from 1990–1993, and joined the faculty at the University of Massachusetts in 1993. He has been the recipient of the NSF

CAREER and Cottrell Scholar awards, as well as the Camille Dreyfus Teacher-Scholar and Sloan Fellowships. He has received the Arthur C. Cope Scholar Award (2023), the Transformational Research and Excellence in Education Award presented by Research Corporation, the Bioorganic Lectureship of the Royal Society of Chemistry (UK), the Australian Nanotechnology Network Traveling Fellowship, the Chinese Academy of Sciences President's International Fellowship for Distinguished Researchers (2016) and the Langmuir Lectureship (2010), and he is a Fellow of both the American Association for the Advancement of Science (AAAS) and of the Royal Society of Chemistry (UK). He was also recognized in 2014, 2015 and 2018–2022 by Thomson Reuters/Clarivate as a "Highly Cited Researcher". His research program focuses on using synthetic organic chemistry to engineer the interface between the synthetic and biological worlds, and spans the areas of devices, polymers, and nanotechnology/bionanotechnology, with over 625 peer-reviewed papers published to date. He is actively involved in the area of bionanotechnology, and his research includes programs in delivery, imaging, diagnostics and nanotoxicology.

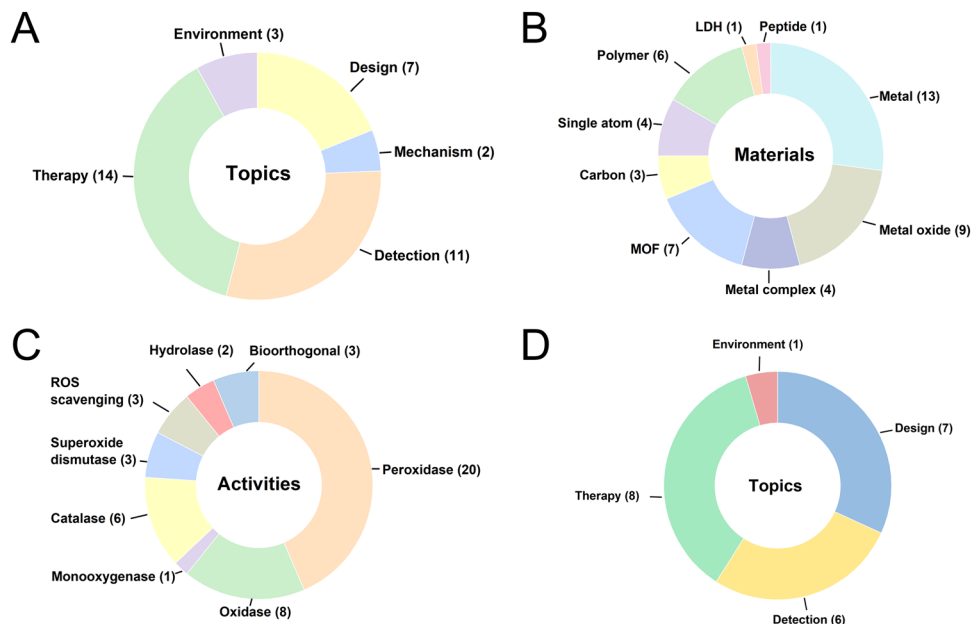


Fig. 1 Analysis of the themed collection: *Nanozymes*. (A) Topics of research articles. (B) Materials used for nanozymes in research articles. (C) Enzyme-like activities mimicked by nanozymes in research articles. (D) Topics of review articles. Numbers in parentheses: the number of publications.

highlights the substantial progress made in the field.

For this collection more than 70% of the publications are original studies, covering topics from nanozyme design and mechanisms to their applications (Fig. 1A). A large number of these papers are focused on detection and therapy, while environmental protection is also represented, consistent with this emerging application. To date,

numerous types of nanomaterials have been exploited to mimic enzymes. Currently, metals, metal oxides, and metal-organic frameworks (MOFs) are most heavily represented, while others are also good candidates, including metal complexes, polymers, carbon, single atoms, layered double hydroxides, and peptides (Fig. 1B). Clearly, most of the studies are focused on oxidoreductase-like activities, ranging from peroxidase,

oxidase, monoxygenase, and catalase to superoxide dismutase and ROS scavenging activities (Fig. 1C). Notably, hydrolase-like nanozymes and bioorthogonal nanozymes have also been investigated by several groups. Over ten reviews (including perspectives and minireviews) are included in the collection. They cover the topics of design, detection, therapy, and environmental protection (Fig. 1D). The range of functionalities



Asier Unciti-Broceta

Asier Unciti-Broceta is Professor of Medicinal Chemistry at the University of Edinburgh and Fellow of the Royal Society of Chemistry. He received his PhD from the Universidad of Granada, Spain, in 2004. After postdoctoral training in the fields of cell delivery and chemical biology at the School of Chemistry of the University of Edinburgh, he took a group leader position in 2010 at the Institute of Genetics and Cancer to create the first

chemistry lab of the Institute. He was promoted to Reader in 2015 and to Full Professor in 2018. His lab is interested in the exploration of novel chemical strategies to improve the efficacy and safety of cancer treatments, including the development of catalytic nano- and microdevices for the controlled activation of anticancer drug precursors.



Hui Wei

Hui Wei is a Professor at Nanjing University and a Fellow of the Royal Society of Chemistry. He received his BS degree from Nanjing University (advisor: Professor Xinghua Xia) and PhD degree from Changchun Institute of Applied Chemistry, Chinese Academy of Sciences (advisor: Professor Erkang Wang). He then joined Professors Yi Lu's and Shuming Nie's groups for two Postdoctoral trainings before he started his independent career at

Nanjing University. His research interests are focused on the design and synthesis of functional nanomaterials (such as nanozymes) and the development of new methodologies for analytical and biomedical applications.

embodied by nanozymes are evidence of the versatility and scope of the technologies that fall under this banner.

As mentioned above, an important proportion of manuscripts of this themed collection have focused on tackling biomedical problems. Scientists have long sought to build miniaturized devices with medical capabilities that can be inoculated into patients to track and treat disease with high precision. While there is still a long way to go, several works from this collection showcase recent advances towards the goal of performing precise theranostic tasks through nanodevices with enzyme-like functionalities. The catalytic capabilities of nanozymes bring the generation of therapeutics and imaging agents to the site of the disease, be it cancer, inflammation,

or other illnesses. Biomimetic nanozymes also provide new pathways to generating reactive species that can kill cells or modulate their activity. Bioorthogonal nanozymes provide *in situ* 'drug factories' that generate drugs and imaging agents where they are needed. Both biomimetic and bioorthogonal strategies open up new therapeutic modalities with the potential to improve disease treatment while minimizing off-target effects. Besides the above interesting applications in detection and therapy, new applications of nanozymes are emerging. For example, nanozymes have been developed for environmental remediation. The combination of photocatalytic nanozymes with sunlight would provide a robust and sustainable way for future environmental protection. It should

be noted that more applications could be explored in the near future, including but not limited to environmental monitoring and antibiofilm applications.

With over 59 articles accepted to date, the interest attracted by this cross-journal collection has far exceeded our expectations. It denotes –nonetheless– the good health of this fascinating, ever-growing topic, which intertwines so many fields of research. We thank the authors for their interest in this initiative and congratulate them for the quality of their work. Nanozymes are working harder than ever.

References

- 1 H. Wei and E. Wang, *Chem. Soc. Rev.*, 2013, **42**, 6060–6093.