Editorial

Nano Biomed Eng

Special Issue: Nanoprobes and Biomedical Imaging

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Citation: D. Ding, Y. Fan, P. Huang. Special issue: nanoprobes and biomedical imaging. *Nano Biomedicine and Engineering*, 2025, 17(1): 1−2.
http://doi.org/10.26599/NBE.2025.9290121

The intersection of nanoprobes and biomedical imaging is a pioneering area that is significantly advancing both modern biomedicine and nanotechnology. This field explores the utilization of nanoscale probes for enhanced visualization, detection, and the ability to be doped with other elements. The development of nanoprobes, their integration with imaging modalities, and their application in preclinical and clinical settings are central to this research area. To celebrate the rapid application development of nanoprobes in biomedical imaging and cancer therapy, this Special Issue entitled "Nanoprobes and Biomedical Imaging" is an innovative collection of nanoprobes studies on biomedical imaging such as high-contrast and deep-tissue imaging, photoacoustic imaging, quantum sensing, and theranostic applications.

This Special Issue begins with a review of *Imaging-guided Companion Theranostics: Ushering in A New Era of Personalized Cancer Care*. This review comprehensively summarizes the development of emerging cancer theranostic technology, particularly companion theranostics (CTx), and formally defines the concept for the first time, thereby establishing a distinct and clear framework that sets it apart from existing diagnostic methods and propels the field of personalized medicine forward [1]. Li et al. describe the diagnostic and therapeutic systems based on second near-infrared (NIR-II) photoacoustic imaging. This topical review focuses on the latest studies of nanotechnology on theranostic applications and explores the role of NIR-II photoacoustic imaging for cancer therapy [2]. In anticancer therapy, magnetic resonance imaging (MRI) emerges as a promising technology for assessing tumor response to treatment [3]. Zhang et al. provide a thorough overview of MRI and its molecular probes in evaluating the effectiveness of cancer therapy. The review delves into the role of MRI in assessing tumor response, highlighting the latest research advancements in MRI technology and its probes within the relevant fields. Yu et al. focus on the application of nanoprobe technology in the diagnosis and treatment of orthopedic diseases, investigating its potential for early and precise diagnosis as well as targeted therapy of prevalent conditions such as osteoarthritis, rheumatoid arthritis, malignant bone tumors, and bone fractures and defects. [4].

Abdullah et al. summarize the plant-derived iron oxide nanoparticles (IONPs) for magnetic hyperthermia and MRI application [5]. They highlight the technical developments of green synthesis of IONPs and surface functionalization of IONPs to improve the effectiveness of magnetic hyperthermia and enhancement of MRI contrast. Copper chalcogenides, particularly CuSe nanoprobes, exhibit unique physicochemical properties, such as strong local surface plasmon resonance (LSPR) in the NIR-II window, Fenton-like catalytic activity, remarkable radiosensitizing and photothermal performance. Li et

al. describe emerging trends and explore future perspectives on the use of CuSe NPs for diagnosing and treating central nervous system diseases, including glioblastoma and neurodegenerative disorders [6]. Graphene quantum dots (GQDs) demonstrate significant potential in enhancing the efficacy of photothermal/photodynamic therapies for cancer treatment and as biosensing probes [7]. There is ample opportunity to further propel the clinical translation of GQD-based phototherapy strategies. Lin et al. develop a novel method for highly sensitive detection and molecular subtyping of breast cancer cells using machine learning-assisted surface-enhanced Raman spectroscopy (SERS). Two SERS bioprobes were synthesized and can detect 4-mercaptobenzoic acid and 4-mercaptopyridine molecules at concentrations as low as 2×10^{-9} mol/L with good spectral stability [8]. The classification accuracy for distinguishing SK-BR-3 cells, MDA-MB-231 cells, and WBCs achieve a high of 97.33%, offering a new technological pathway for early breast cancer diagnosis and personalized treatment. To enhance near-infrared IIb (NIR-IIb) emission of Er (III) complexes, Yang et al. synthesize an amphiphilic diblock copolymer (PEG112–PAA12) to coordinate with Er (III), then doped Ytterbium (Yb) to form the PEG–PAA–Er/Yb complex, which showed a significant fluorescence enhancement of about 250 times at ~1 525 nm laser irradiation [9]. In food safety monitoring, Patil et al. develop a fluorescent nanoprobe using carbon quantum dots (CQDs) synthesized from tamarind leaves via a hydrothermal method for detecting potassium dichromate in milk [10]. The CQDs-based nanoprobe demonstrates high selectivity and accuracy in spiked milk samples, showing potential for practical application in food safety testing.

This Special Issue explores diverse aspects of the latest nanoprobe applications in biomedical imaging and cancer therapy. It is expected that the results and findings in this issue will provide valuable insights for researchers specializing in nanobiotechnology. Lastly, we are truly grateful to each author who has contributed their novel research findings to this Special Issue.

Acknowledgments

We would like to thank all authors and reviewers who have contributed to this Special Issue.

Funding

This research received no external funding.

Conflict of Interests

The authors declare no conflict of interest.

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