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Editorial

Special Issue "Functional Biomolecule-Based Composites and Nanostructures: Current Developments and Applications—A Themed Issue in Honor of Prof. Dr. Itamar Willner"

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This Special Issue of *Chemistry* is a themed issue of "Functional Biomolecule-Based Composites and Nanostructures: Current Developments and Applications" in honor of Itamar Willner to celebrate his innovative research career. The Issue includes 8 reviews and 12 research articles, with contributors from China, the USA, Japan and Canada.

Prof. Willner is currently a professor of Chemistry at the Hebrew University of Jerusalem. He is a fellow of the American Association for the Advancement of Science (AAAS), a member of the Israel Academy of Sciences, a member of the German National Academy of Sciences Leopoldina and a member of the Chinese Academy of Sciences. His research scientific activities represent an interdisciplinary effort to bridge chemistry, biology and materials science. His research interests cover of a broad range of fields, including supramolecular chemistry, DNA nanotechnology, molecular self-assembly, molecular and biomolecular machines, molecular and biomolecular electronics, sensors and biosensors, electronics and the photophysics of nanoparticles and quantum dots, functionalized monolayers, molecular optoelectronics, optobioelectronics, photocatalysis, photoinduced electron transfer, artificial photosynthesis and biofuel cells. Prof. Willner is the author of more than 1000 publications, with more than 89,000 citations. Prof. Willner had a very large number of graduate and post-doctoral students, many of whom are currently holding academic positions in Israel and around the world.

In the past 20 years, one of the major activities of Prof. Willner and his coworkers has been DNA nanotechnology, including the dynamic assembly of DNA nanostructures, DNA machines and DNA calculation. His contributions to DNA nanotechnology are summarized in several excellent reviews [1–3]. Consequently, this themed Issue involves a heavy portion of DNA composites and nanostructures. Chao and coworkers provide a comprehensive summary of the latest updated research progress of the dynamic DNA nanodevice and explore its future application prospects [Contributor 1]. Liu and coworkers discuss the advancements in stimuli-responsive DNA nanostructure construction and their applications in biomolecule sensing and cancer treatment [Contributor 2]. Wu et al. summarize the recent development of DNA-based mechanical sensors and their applications in measuring mechanical forces in the extracellular matrix and cell–cell interactions and demonstrate the latest advances in monitoring and manipulating cellular morphology and function [Contributor 3]. Li, Pu and Huang et al. introduce a special DNA nanostructure, programmatically self-assembled DNA nanospheres, and summarize its biological applications, specifically as nanocarriers for drug delivery, bioimaging agents and drugs for bioassays, bioimaging and tumor therapy [Contributor 4]. Lu et al. demonstrate a strategy to construct an ATP-activated Y-Shape DNA probe for smart miRNA imaging in living cells [Contributor 5].

In addition to DNA nanostructures, other fields in DNA nanotechnology are also involved in this themed Issue. Wang and coworkers present recent progress on DNA-encoded

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metal nanoclusters, focusing on their applications in the fields of analysis, logic operation and therapy based on properties including fluorescence, electrochemiluminescence and antibacterial and catalytic activity [Contributor 6]. He and coworkers summarize developments in DNA nanotechnology-empowered fluorescence imaging for APE1 activity and highlight the future research directions in the field of APE1 activity imaging [Contributor 7]. Shao et al. focus on the catalytic property of DNA and develop a photocatalytic DNAzyme by introducing an abasic site to switch its photocatalytic activity [Contributor 8]. Aptamers are artificial oligonucleotides with excellent molecule-targeting ability. Wang et al. focus on the recent advances in aptamer-based immune drug systems and highlight their advantages in cancer immunotherapy [Contributor 9]. Liu et al. use a DNA aptamer for antibiotics and design a fluorescence sensor for tetracycline [Contributor 10].

In the field of DNA-based calculation and data storage, Liu et al. demonstrate a piece of DNA Origami Cryptography (DOC) technology, which hides the encrypted message in the DNA strands and encapsulates them within the SiO_2 shell to ensure the confidentiality and integrity of the transmitted message. This encryption method in messaging offers a high level of concealment and security during the process of message transmission [Contributor 11]. Dong et al. demonstrate a DNA logic gate system using coupling 2-aminopurine coupling DNA copper nanoparticles (CuNPs) and fabricate a rapid and enzyme-free system for operating DNA contrary logic pairs (D-CLPs) [Contributor 12].

The sensing application using DNA materials is also discussed in this special-themed Issue. Lu and Zhang et al. design a ratiometric sensor for Zn^{2+} using a DNAzyme-based bioluminescence resonance energy transfer assay. This sensor enables the measurement of Zn^{2+} in human serum with a smartphone [Contributor 13]. Kong et al. harness the signal amplification of the rolling circle amplification (RCA) of DNA to design a sensitive and specific sensor for HClO and Myeloperoxidase [Contributor 14]. Mori et al. take a DNA origami as a scaffold to assemble three different fluorophores, i.e., pH-sensitive fluorescein and Oregon Green, as well as pH-insensitive tetramethylrhodamine, to provide a ratiometric fluorescent pH probe. This ratiometric pH probe covers a wider pH detection range for measuring the variation of intracellular pH [Contributor 15].

Besides DNA materials, the applications of other functional biomolecule-based composites are also introduced. Luo et al. summarize the latest research on functional peptides as gene delivery vectors in improving transfection efficiency [Contributor 16]. Ge et al. show a novel synthesis route to encapsulate enzymes in metal–organic frameworks (MOF). This enzyme–MOF composite holds high thermal stability up to 180 °C, which paves a new path for expanding the industrial application of enzymes [Contributor 17]. Xia et al. present solid-state processes for the fabrication of copper nanoclusters and hierarchical supraparticles. These two as-prepared types of copper nano-materials hold favorable optical properties for bio-imaging and bio-sensing [Contributor 18]. Yan et al. construct a triangle ensemble of Pt clusters for the enhanced direct-pathway electrocatalysis of formic acid oxidation [Contributor 19]. Li et al. investigate the feasibility of accelerating the peroxidase-like reaction rate of CuO nanostructures through Fe doping. With the improved peroxidase-like activity, the Fe-CuO nanozyme facilitates the construction of a visual sensing platform for the sensitive and selective determination of ascorbic acid [Contributor 20].

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Conflicts of Interest: The author declares no conflict of interest.

List of Contributions:

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