https://pmc.ncbi.nlm.nih.gov/articles/PMC165810/

Viral assembly of oriented quantum dot nanowires

Abstract

The highly organized structure of M13 bacteriophage was used as an evolved biological template for the nucleation and orientation of semiconductor nanowires. To create this organized template, peptides were selected by using a pIII phage display library for their ability to nucleate ZnS or CdS nanocrystals. The successful peptides were expressed as pVIII fusion proteins into the crystalline capsid of the virus. The engineered viruses were exposed to semiconductor precursor solutions, and the resultant nanocrystals that were templated along the viruses to form nanowires were extensively characterized by using high-resolution analytical electron microscopy and photoluminescence. ZnS nanocrystals were well crystallized on the viral capsid in a hexagonal wurtzite or a cubic zinc blende structure, depending on the peptide expressed on the viral capsid. Electron diffraction patterns showed single-crystal type behavior from a polynanocrystalline area of the nanowire formed, suggesting that the nanocrystals on the virus were preferentially oriented with their [001] perpendicular to the viral surface. Peptides that specifically directed CdS nanocrystal growth were also engineered into the viral capsid to create wurtzite CdS virus-based nanowires. Lastly, heterostructured nucleation was achieved with a dual-peptide virus engineered to express two distinct peptides within the same viral capsid. This work represents a genetically controlled biological synthesis route to a semiconductor nanoscale heterostructure.

https://www.nature.com/articles/s41563-024-02114-5

Blood–brain-barrier-crossing lipid

nanoparticles for mRNA delivery to the central nervous system

Abstract

The systemic delivery of mRNA molecules to the central nervous system is challenging as they need to cross the blood–brain barrier (BBB) to reach into the brain. Here we design and synthesize 72 BBB-crossing lipids fabricated by conjugating BBB-crossing modules and amino lipids, and use them to assemble BBB-crossing lipid nanoparticles for mRNA delivery. Screening and structure optimization studies resulted in a lead formulation that has substantially higher mRNA delivery efficiency into the brain than those exhibited by FDA-approved lipid nanoparticles. Studies in distinct mouse models show that these BBB-crossing lipid nanoparticles can transfect neurons and astrocytes of the whole brain after intravenous injections, being well tolerated across several dosage regimens. Moreover, these nanoparticles can deliver mRNA to human brain ex vivo samples. Overall, these BBB-crossing lipid nanoparticles deliver mRNA to neurons and astrocytes in broad brain regions, thereby being a promising platform to treat a range of central nervous system diseases.

https://ieeexplore.ieee.org/abstract/document/10896685

Microwave Technique for Brain Monitoring: State of the Art, Promising Applications, Challenges, and Future Directions

Abstract:

The brain is considered one of the central organs constituting complex biological phenomena that reflect upon the health and well-being of a person. Wearable brain monitoring systems have witnessed increased research and technological achievements in the last two decades. Microwave-based techniques have demonstrated high potential for brain monitoring and have technological benefits, such as non-ionizing radiation, small size, cost-effectiveness, portability, non-invasive operation, and good penetration depth. This review aims to present a

critical analysis of research on the utilization of microwaves for brain monitoring. Followed by a comprehensive literature search and thematic analysis, four Research Questions (RQs) related to microwave systems in brain monitoring are formulated and studied. In response to these RQs, the key approaches for microwave modeling of the human brain are explored. Further, a brief outline of different applications focusing on developments in microwave systems for brain temperature measurement, stroke detection, intracranial pressure (ICP) monitoring, and skull fracture detection are elaborated. Additionally, thematic analysis is presented in each application area on inter-technology comparison of the microwave technique with other technologies. Further, the challenges in the development of microwave systems and their clinical usage in different brain monitoring setups are explored along with future directions. This review can serve as a platform for brain researchers to understand the potential of the emerging microwave technology for brain monitoring.

https://pmc.ncbi.nlm.nih.gov/articles/PMC5177684/

Virus-Based Nanoparticles as Versatile Nanomachines

Abstract

Nanoscale engineering is revolutionizing the way we prevent, detect, and treat diseases. Viruses have played a special role in these developments because they can function as prefabricated nanoscaffolds that have unique properties and are easily modified. The interiors of virus particles can encapsulate and protect sensitive compounds, while the exteriors can be altered to display large and small molecules in precisely defined arrays. These properties of viruses, along with their innate biocompatibility, have led to their development as actively targeted drug delivery systems that expand on and improve current pharmaceutical options. Viruses are naturally immunogenic, and antigens displayed on their surface have been used to create vaccines against pathogens and to break self-tolerance to initiate an immune response to dysfunctional proteins. Densely and specifically

aligned imaging agents on viruses have allowed for high-resolution and noninvasive visualization tools to detect and treat diseases earlier than previously possible. These and future applications of viruses have created an exciting new field within the disciplines of both nanotechnology and medicine.