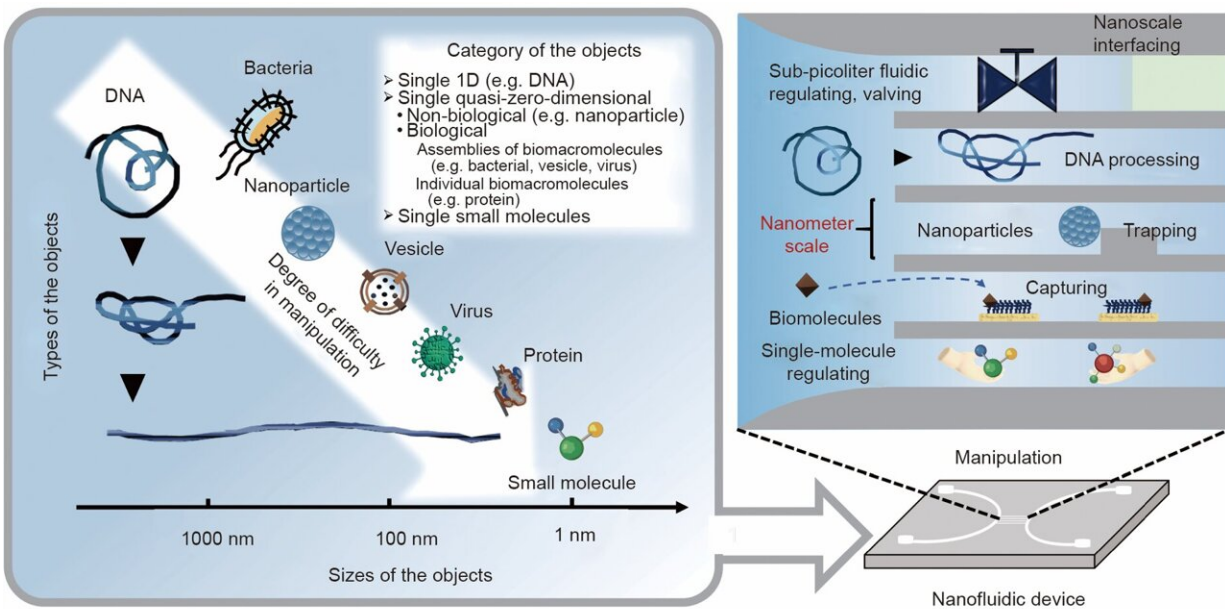


Nanofluidic devices and their role in matter manipulation

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Potential of nanofluidic devices for manipulating individual nanometric objects(illustration). Revolutionizing: Nanofluidic devices enable precise manipulation of single DNA, nanoparticles, biomolecules, and small molecules through innovative techniques like processing, trapping, capturing, and manipulating. These breakthroughs open new frontiers in science, engineering, and industry. Credit: *Engineering* (2024). DOI: 10.1016/j.eng.2024.08.021

One of the great ambitions in the scientific world is to use tiny objects—such as molecules, viruses, and nanoparticles—as building

blocks to construct essential macromolecules and materials, much like constructing intricate designs with LEGO bricks. However, achieving this requires overcoming significant challenges.

Molecules in liquid environments move randomly and at extraordinary speeds—approximately many times faster than Usain Bolt at peak velocity—making precise manipulation extraordinarily challenging.

To address these challenges, nanofluidic devices have emerged as a groundbreaking innovation. These advanced tools are designed with ultra-narrow channels, comparable in size to individual nanoscale objects, and leverage nanofluidic processes—such as trapping mechanisms—to suppress random motion and enable precise manipulation.

This allows researchers to transport and control individual nanoscale objects, ranging from viruses to DNA and single small molecules, with extraordinary precision. By offering an unprecedented level of control, nanofluidic devices overcome existing limitations in nanoscale handling, paving the way for transformative advancements in science, engineering, and industry.

A new review article [published](#) in the journal *Engineering* provides a panoramic view of the field's advancements, future challenges, and transformative potential. The study highlights the core technologies driving this emerging field, including nanofluidic processing, functional integration, and precise fluidic control.

By bridging diverse disciplines through innovative nanofluidic methodologies, the authors have laid a foundation for practical applications that extend well beyond current capabilities.

The researchers also address critical challenges, such as the precise manipulation of molecules in solution and the seamless integration of

nanofluidic devices with complementary technologies, including optical and magnetic forces. These future innovations will pave the way for molecular robotics.

The potential fusion of these technologies with [data science](#) and [artificial intelligence](#) could drive a [paradigm shift](#), revolutionizing fields such as chemistry, biology, chemical engineering, materials science and engineering, and information processing.

Furthermore, nanofluidic manipulation also drives faster, energy-efficient systems, fueling advancements in artificial intelligence and quantum computing. These future innovations have the potential to create new industries, shape future technologies, and redefine the landscape of science and engineering.

More information: Nattapong Chantipmanee et al, Nanofluidic Manipulation of Single Nanometric Objects: Current Progress, Challenges, and Future Opportunities, *Engineering* (2024). [DOI: 10.1016/j.eng.2024.08.021](#)

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