Combinatorial multiplexing enhanced high throughput microfluidic DNA random access memory (MDRAM)

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The exponential generation of digital information will soon exhaust the capacity of silicon-based information data storage platforms. DNA has emerged as an alternative for archival data storage, offering higher information storage density, long-term stability, and lower operation energy. However, the practical implementation of DNA data storage as an industrially viable technology faces several challenges, including higher information writing and reading latency, synthesis-associated costs, and the need for sophisticated laboratory infrastructure. Microfluidics technology has demonstrated capabilities to handle liquids at micro and nanoscales in a highly integrated fashion and offers a potential solution to these challenges. Microfluidics enables precise manipulation of liquids and (bio)chemical reactions, making it ideal for applications in DNA data storage. This study introduces Microfluidic Random Access Memory (MDRAM) as a novel approach for achieving high-throughput DNA data storage. By leveraging combinatorial multiplexing for dynamic reconfigurability enabled via rapid prototyping, we develop MDRAM architecture to streamline digital information storage in DNA. We demonstrate that the files can be densely stored, retrieved, and processed for sequencing with efficient store-to-read latency.