DNA-BASED DIGITAL INFORMATION STORAGE

CROSS-REFERENCE

[0001] This application claims the benefit of U.S. provisional patent application number 62/613,728 filed on January 4, 2018; U.S. provisional patent application number 62/617,067 filed on January 12, 2018; and U.S. provisional patent application number 62/650,231 filed on March 29, 2018, all of which are incorporated herein by reference in their entirety.

BACKGROUND

[0002] Biomolecule based information storage systems, *e.g.*, DNA-based, have a large storage capacity and stability over time. However, there is a need for scalable, automated, highly accurate and highly efficient systems for generating biomolecules for information storage.

BRIEF SUMMARY

[0002a] Provided herein is a device for storing information, comprising: a solid support, wherein the solid support comprises a plurality of wells, wherein the solid support comprises addressable loci at a density of at least 100 x 10^6 addressable loci per cm^2, ~~wherein a voltage can be independently applied to each of the addressable loci,~~ wherein each of the wells comprises an addressable locus comprising: a planar synthesis surface located in a bottom region of each of the wells~~;~~, wherein the planar synthesis surface includes at least one nucleoside coupled to a polynucleotide; a bottom electrode in addressable communication with the synthesis surface ~~such that activation of the bottom electrode controls a chemical reaction on the planar synthesis surface~~; and at least one sidewall electrode located on a sidewall of each of the wells, wherein the at least one sidewall electrode is 50 nm to 200 nm from the planar synthesis surface and wherein a voltage is independently applied to each of the addressable loci by the at least one sidewall electrode.

[0003] Provided herein are devices for storing information, comprising: a solid support, wherein the solid support comprises a plurality of wells, wherein each of the wells comprises an addressable locus comprising: a synthesis surface located in a bottom region of each of the wells; a bottom electrode in addressable communication with the synthesis surface; and at least one sidewall electrode located on a sidewall of each of the wells, wherein the at least one sidewall electrode is 50 nm to 200 nm from the bottom region. Further provided herein are devices wherein the solid support comprises addressable loci at a density of at least 100 x10^6 addressable loci per cm^2. Further provided herein are devices wherein the solid support comprises addressable loci at a density of 100 x 10^6 to 100 x 10^7 addressable loci per cm^2. Further provided herein are devices wherein the addressable locus comprises a diameter up to about 750 nm. Further provided herein are devices wherein each of the wells comprises a depth up to about 1000 nm. Further provided

herein are devices wherein each of the wells comprises a depth of 100 nm to 1000 nm. Further provided herein are devices wherein each of the wells comprises a longest cross-sectional diameter of 100 nm to 800 nm. Further provided herein are devices wherein each of the wells is cylindrical. Further provided herein are devices wherein the bottom electrode comprises a longest cross-sectional area of 10^4 nm^2 to 10^5 nm^2. Further provided herein are devices wherein the at least one sidewall electrode is 50 nm to 200 nm from the bottom region. Further provided herein are devices wherein the at least one sidewall electrode comprises a height of 5 nm to 25 nm. Further provided herein are devices comprising at least two sidewall electrodes. Further provided herein are devices wherein the at least one sidewall electrode and the bottom electrode are independently addressable.

[0004] Provided herein are devices for storing information, comprising: a solid support, wherein the solid support comprises a plurality of wells, wherein each of the wells comprises an addressable

CLAIMS

WHAT IS CLAIMED IS:

1. A device for storing information, comprising:

a solid support, wherein the solid support comprises a plurality of wells, wherein the solid support comprises addressable loci at a density of at least 100 x 10^6 addressable loci per cm^2, ~~wherein a voltage can be independently applied to each of the addressable loci,~~ wherein each of the wells comprises an addressable locus comprising:

a planar synthesis surface located in a bottom region of each of the wells~~;~~, wherein the planar synthesis surface includes at least one nucleoside coupled to a polynucleotide;

a bottom electrode in addressable communication with the synthesis surface ~~such that activation of the bottom electrode controls a chemical reaction on the planar synthesis surface~~; and

at least one sidewall electrode located on a sidewall of each of the wells, wherein the at least one sidewall electrode is 50 nm to 200 nm from the planar synthesis surface and wherein a voltage is independently applied to each of the addressable loci by the at least one sidewall electrode.

2. The device of claim 1, wherein the solid support comprises addressable loci at a density of 100 x 10^6 to 100 x 10^7 addressable loci per cm^2.
3. The device of claim 1, wherein the addressable locus comprises a diameter up to 750 nm.
4. The device of claim 1, wherein each of the wells comprises a depth up to 1000 nm.
5. The device of claim 1, wherein each of the wells comprises a depth of 100 nm to 1000 nm.
6. The device of claim 1, wherein each of the wells comprises a longest cross-sectional diameter of 100 nm to 800 nm.
7. The device of claim 1, wherein each of the wells is cylindrical.
8. The device of claim 1, wherein the bottom electrode comprises a cross-sectional area of 10^4 nm^2 to 10^5 nm^2.

9. The device of claim 1, wherein the at least one sidewall electrode is 75 nm to 125 nm from the planar synthesis surface.
10. The device of claim 1, wherein the at least one sidewall electrode comprises a height of 5 nm to 25 nm.
11. The device of claim 1, comprising at least two sidewall electrodes.
12. The device of claim 1, wherein the at least one sidewall electrode and the bottom electrode are independently addressable.
13. A method for storing information, comprising:
    a) providing a device of claim 1;
    b) providing instructions for polynucleotide synthesis;
    c) depositing at least one nucleoside on the synthesis surface, wherein the at least one nucleoside couples to a polynucleotide attached to the synthesis surface; and
    d) repeating step c) to synthesize a plurality of polynucleotides on the synthesis surface, wherein the instructions comprise at least one sequence encoding for the plurality of polynucleotides.
14. The method of claim 13, wherein the method further comprises cleaving at least one polynucleotide from the surface, wherein the polynucleotide is dissolved in a droplet.
15. The method of claim 13, wherein the method further comprises sequencing at least one polynucleotide from the surface.
16. The method of claim 13, wherein the nucleoside comprises a nucleoside phosphoramidite.
17. The method of claim 13, wherein the method further comprises a cleavage step, wherein the cleavage step comprises applying an electrical potential to the bottom electrode to generate a cleavage reagent.
18. The method of claim 13, wherein the method further comprises an oxidation step.
19. The method of claim 13, wherein the method further comprises a deblocking step, wherein the deblocking step comprises applying an electrical potential to the at least one sidewall electrode to generate a deprotection reagent.