WHAT IS CLAIMED:

1. A sequencing-by-synthesis (SBS) method comprising:

providing a detection apparatus that includes an array of magnetically-responsive sensors, each of the magnetically-responsive sensors being located proximate to a respective designated space to detect a magnetic property therefrom, the detection apparatus also including a plurality of nucleic acid template strands located within corresponding designated spaces;

conducting a plurality of SBS events to grow a complementary strand by incorporating nucleotides along each template strand, at least some of the nucleotides being attached to corresponding magnetic particles having respective magnetic properties, wherein each of the plurality of SBS events includes detecting changes in electrical resistance at the magnetically-responsive sensors caused by the respective magnetic properties of the magnetic particles;

determining genetic characteristics of the complementary strands based on the detected changes in electrical resistance;

wherein the magnetic particles permanently change the magnetizations of the corresponding magnetically-responsive sensors such that the magnetizations of the corresponding magnetically-responsive sensors are maintained after the magnetic particles are removed, wherein the method includes changing the magnetization of at least some of the magnetically-responsive sensors after reading the magnetically-responsive sensors and wherein reading the magnetically-responsive sensors occurs after the magnetic particles have been removed.

2. The method of claim 1, wherein the magnetically-responsive sensors includes a magnetoresistive sensor.

3. The method of claim 1, wherein determining the genetic characteristic of the complementary strands includes analyzing the detected changes in electrical resistance to determine whether signals based on the detected changes form a designated pattern.

4. The method of claim 1, wherein the nucleotides include multiple types of nucleotides, each type of nucleotide having a different number of magnetic particles attached thereto than other types of nucleotides.

5. The method of claim 4, wherein the magnetic particles are single-molecule magnets (SMMs).

6. The method of claim 1, wherein one or more of the magnetic particles are linked to the gamma phosphate of the nucleotide, the magnetic particle being released when the polymerase adds the nucleotide to the complementary strand.

7. The method of claim 1, wherein each designated space includes a single template strand that is immobilized to a substrate surface of the detection apparatus.

8. A sequencing-by-synthesis (SBS) system comprising:

a detection apparatus including an array of magnetically-responsive sensors, each of the magnetically-responsive sensors including at least two ferromagnetic layers and a non-magnetic layer that separates the two ferromagnetic layers, each of the magnetically-responsive sensors forming at least one of a giant magnetoresistance (GMR) sensor or a tunnel magnetoresistance (TMR) sensor, the magnetically-responsive sensors being positioned adjacent to corresponding designated spaces within a chamber and configured to detect magnetic particles from the corresponding designated spaces;

the detection apparatus including a plurality of nanowells separated by interstitial spaces, wherein the designated spaces comprise a hydrophilic layer within either the nanowells or the interstitial spaces;

a readout circuit communicatively coupled to the magnetically-responsive sensors, wherein the readout circuit is configured to transmit signals that correspond to electrical resistances of the magnetically-responsive sensors; and

a fluidic-control system is configured to flow reagents through the chamber for conducting an SBS protocol, the reagents including a plurality of types of nucleotides, wherein the readout circuit is configured to transmit the signals after each incorporation event.

9. The system of claim 8, wherein the fluidic-control system is configured to:

(a) flow nucleotides to the designated spaces to add the nucleotides to complementary strands; and

(b) flow magnetic particles to the designated spaces, the magnetic particles attaching to the nucleotides, the magnetic particles exhibiting a corresponding detectable magnetic property;

wherein the readout circuit is configured to detect the electrical resistance at the magnetically-responsive sensors after (b).

10. The system of claim 8, wherein the fluidic-control system is configured to:

(a) deliver nucleotides to the designated spaces to add the nucleotides to the complementary strands, the nucleotides including at least first, second, and third nucleotides, the first, second, and third nucleotides having different bases;

(b) deliver magnetic particles to the designated spaces, the magnetic particles attaching to the first nucleotides and to the second nucleotides;

(c) deliver magnetic particles to the designated spaces, the magnetic particles attaching to the third nucleotides;

wherein the readout circuit is configured to detect the electrical resistance at the magnetically-responsive sensors after (b) and after (c).

11. The system of claim 8, wherein each designated space is on a hydrophilic layer that is surrounded by a hydrophobic layer.

12. A sequencing-by-synthesis (SBS) method comprising:

providing a detection apparatus that includes an array of magnetically-responsive sensors, each of the magnetically-responsive sensors being located proximate to a respective designated area to detect a magnetic property therefrom, the detection apparatus also including polymerase immobilized to the designated areas, the polymerase configured to capture a corresponding template strand;

conducting a plurality of SBS events to grow a complementary strand by incorporating nucleotides along a corresponding template strand, the nucleotides being attached to corresponding magnetic particles having respective magnetic properties,

wherein each of the plurality of SBS events includes detecting changes in electrical resistance at the magnetically-responsive sensors caused by the respective magnetic properties of the magnetic particles as the nucleotides are added to the complementary strand; wherein the nucleotides include multiple types of nucleotides, at least one of the nucleotide types to yield varying magnitude in electrical resistance over multiple predetermined time periods; and

determining genetic characteristics of the complementary strands based on the detected changes in electrical resistance, including the varying magnitude in electrical resistance over multiple predetermined time periods.

13. The method of claim 12, wherein determining the genetic characteristic of the complementary strands includes analyzing the detected changes in electrical resistance to determine whether signals based on the detected changes form a designated pattern.

14. The method of claim 12, wherein determining the genetic characteristics includes determining sequences of the complementary strands, the sequences of the complementary strands being based on the detected changes in electrical resistance that occurred at the magnetically-responsive sensors for each of the plurality of SBS events.

15. The method of claim 14, wherein determining the sequences of the complementary strands includes determining magnitudes of changes in electrical resistance at the magnetically-response sensors.

16. The method of claim 12, wherein the multiple types of nucleotides each have a different number of magnetic particles attached thereto.

17. The method of claim 16, wherein the magnetic particles are single-molecule magnets (SMMs).

18. The method of claim 12, wherein the multiple types of nucleotides each have a different type of magnetic particle attached thereto.

19. The method of claim 12, wherein each of the plurality of SBS events includes delivering multiple types of nucleotides simultaneously.

20. The method of claim 12, wherein each designated area includes a single template strand that is captured by the polymerase.

21. The method of claim 12, wherein the magnetically-responsive sensors includes a magnetoresistive sensor.

22. The method of claim 12 wherein one or more of the magnetic particles are linked to the gamma phosphate of the nucleotide, the magnetic particle being released when the polymerase adds the nucleotide to the complementary strand.

23. The method of claim 12, wherein the magnetic particles permanently change the magnetizations of the corresponding magnetically-responsive sensors such that the magnetizations of the corresponding magnetically-responsive sensors are maintained after the magnetic particles are removed, wherein the method includes changing the magnetization of at least some of the magnetically-responsive sensors after reading the magnetically-responsive sensors.

24. The method of claim 23 wherein reading the magnetically-responsive sensors occurs after the magnetic particles have been removed.