

CLAIMS

WHAT IS CLAIMED IS:

- 5 1. An electrophoretic system for analyte migration, the system comprising:
a substrate including a plurality of regions, each region configured to be electrically
conductive, each region configured to comprise one or more capture probes and a biological
sample comprising an analyte, wherein the substrate includes a first electrode contact, the first
electrode contact being electrically connected to at least one of the plurality of regions, the
10 substrate including a conductive material, the conductive material including at least one of tin
oxide (TO), indium tin oxide (ITO), a transparent conductive oxide (TCO), aluminum doped zinc
oxide (AZO), fluorine doped tin oxide (FTO), or any combination thereof;
a substrate cassette configured to be disposed at the substrate and including a plurality of
apertures corresponding to the plurality of regions of the substrate, the plurality of apertures
15 configured to define a plurality of buffer chambers comprising the plurality of regions of the
substrate, wherein the substrate cassette comprises a connection interface electrically coupled to
the first electrode contact of the substrate;
a cathode assembly including a plurality of electrodes positioned within the plurality of
buffer chambers of the substrate cassette, respectively, wherein the cathode assembly includes a
20 second electrode contact, the second electrode contact being electrically connected to at least one
of the plurality of electrodes; and
a power supply electrically connected with the first electrode contact of the substrate at
the connection interface of the substrate cassette, and electrically connected with the second
electrode contact of the cathode assembly, the power supply configured to generate an electric
25 field between the plurality of regions and the plurality of electrodes, respectively, such that the
analyte in the biological sample moves toward the one or more capture probes on the substrate.
2. The electrophoretic system of claim 1, wherein the plurality of buffer chambers are
configured to receive a buffer, and wherein the buffer includes a permeabilization reagent.
- 30 3. The electrophoretic system of claim 1, further comprising:
a light configured to illuminate onto the plurality of regions.

4. The electrophoretic system of claim 1, further comprising:
a first contact pin electrically attached to the substrate and providing the first electrode
contact,

5 wherein the substrate cassette includes:
a body defining a cavity configured to receive the substrate,
wherein the connection interface of the substrate cassette includes a contact hole
defined at the body and configured to expose the first contact pin therethrough;
wherein the body includes a main face and a lateral face extending from a periphery of
10 the main face,
wherein the plurality of the apertures are defined at the main face of the body, and
wherein the contact hole is defined at the main face.

5. The electrophoretic system of claim 1, wherein the substrate cassette includes:
15 a body defining a cavity configured to receive the substrate; and
a contact pin extending through a wall of the body and having a first end and a second
end opposite to the first end, the first end arranged exterior of the body, and the second end
arranged interior of the body and configured to electrically contact with the first electrode
contact of the substrate.

20 6. The electrophoretic system of claim 5, further comprising:
a contact bracket that electrically engages with the substrate and provides the first
electrode contact of the substrate,
wherein the second end of the contact pin is configured to electrically contact with the
25 contact bracket.

7. The electrophoretic system of claim 1, wherein the substrate cassette includes a second
aperture corresponding to the first electrode contact of the substrate and configured to define a
second buffer chamber on the first electrode contact of the substrate,
30 wherein the plurality of buffer chambers are configured to contain a first buffer, and

wherein the second buffer chamber is configured to contain a second buffer different from the first buffer;

wherein the second buffer has an electrolyte strength greater than the first buffer;

wherein the cathode assembly includes:

5 a cathode body configured to position at least partially on the substrate cassette, wherein the plurality of electrodes projecting from the cathode body and configured to position within the plurality of buffer chambers, respectively; and

 a second electrode projecting from the cathode body and configured to position within the second buffer chamber.

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8. The electrophoretic system of claim 7, wherein the cathode body includes:

 an anode contact that is electrically connected to the second electrode,

 wherein the power supply is electrically connected to the anode contact of the cathode body so that the power supply is electrically connected with the first electrode contact of the

15 substrate via the second electrode that positions within the second buffer chamber containing the second buffer on the first electrode contact of the substrate.

9. The electrophoretic system of claim 1, wherein the substrate cassette includes:

 a cassette body defining a cavity configured to receive the substrate, wherein the cassette

20 body includes the cathode assembly such that the plurality of electrodes are configured to position within the plurality of buffer chambers; and

 a plurality of cathode contact pins extending through a wall of the cassette body and electrically contacting with the second electrode contact such that the cathode contact pin is electrically connected to the at least one of the plurality of electrodes;

25 wherein each of the plurality of electrodes includes at least one of a conductive wire, a conductive rod, or an array of conductive wires; and

 wherein each of the plurality of electrodes includes a conductive plate at a distal end of the at least one of the conductive wire, the conductive rod, or the array of conductive wires.

30 10. The electrophoretic system of claim 9, wherein the cassette body includes:

 an anode contact pin extending through the wall of the cassette body and having a first

end and a second end opposite to the first end, the first end arranged exterior of the cassette body and the second end arranged interior of the cassette body and configured to electrically contact with the first electrode contact of the substrate.

5 11. The electrophoretic system of claim 10, further comprising:

a contact bracket that electrically engages with the substrate and provides the first electrode contact of the substrate,

wherein the second end of the anode contact pin is configured to electrically contact with the contact bracket.

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12. The electrophoretic system of claim 1, wherein the substrate cassette includes:

a body defining a cavity configured to partially receive the substrate,

wherein the connection interface of the substrate cassette includes a slit defined at the body and configured for the substrate to partially extend out from the body such that the first electrode contact of the substrate is positioned outside the body;

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wherein the body includes the cathode assembly such that the plurality of electrodes are configured to position within the plurality of buffer chambers,

wherein the substrate cassette further includes:

a cathode contact pin extending through a wall of the body and electrically contacting with the second electrode contact such that the cathode contact pin is electrically connected to the at least one of the plurality of electrodes;

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an anode contact pin extending from the body; and

a conductive wire having a first end and an opposite second end, the first end electrically connected to the anode contact pin, and the second end electrically connected to the first electrode contact that is positioned outside the body.

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13. The electrophoretic system of claim 1, wherein the substrate cassette includes a body defining a cavity configured to partially receive the substrate, wherein the connection interface of the substrate cassette includes a slit defined at the body and configured for the substrate to partially extend out from the body such that the first electrode contact of the substrate is positioned outside the body; and

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the electrophoretic system further comprising:

an anode cassette body defining a cavity configured to receive the first electrode contact of the substrate that is positioned outside the body of the substrate cassette; and

an anode contact pin extending through a wall of the anode cassette body and
5 having a first end and a second end opposite to the first end, the first end arranged exterior of the anode cassette body and the second end arranged interior of the anode cassette body and configured to electrically contact with the first electrode contact of the substrate.

14. The electrophoretic system of claim 5, further comprising:

10 a system housing including the power supply;

a cassette tray that extends from the system housing and is configured to receive the substrate cassette thereon; and

a cassette cover that extends from the system housing above the cassette tray and includes the cathode assembly, wherein the plurality of electrodes project from the cassette cover toward
15 the plurality of buffer chambers of the substrate cassette, the cassette cover further including:

an anode connector configured to electrically engage with the contact pin of the substrate cassette.

15. A method for analyte migration, the method comprising:

20 loading a substrate comprising capture probes with a substrate cassette into an electrophoresis instrument, the substrate cassette including a plurality of buffer chambers, the substrate including a plurality of regions each comprising one or more capture probes and a biological sample containing an analyte;

arranging a cathode to place a plurality of electrodes within the plurality of buffer
25 chambers, respectively;

electrically connecting a power supply to the substrate;

electrically connecting the power supply to the cathode;

applying a first voltage between the substrate and the cathode;

detecting an output parameter in response to the first voltage;

30 determining whether the output parameter meets a threshold value; and

based on the output parameter meeting the threshold value, applying a second voltage to generate electric fields between the plurality of regions of the substrate and the plurality of electrodes through the plurality of buffer chambers to cause the analytes in the biological sample to move toward the capture probes on the substrate.

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16. The method of claim 15, wherein the output parameter is an impedance.

17. The method of claim 15, wherein the threshold value is indicative of a propriety of at least one of an electrical connection of the power supply to the substrate, an electrical connection
10 of the power supply to the cathode, or an electrical property of one or more buffers within the plurality of buffer chambers.

18. The method of claim 15, further comprising:
based on the output parameter not meeting the threshold value, generating a notification
15 to inform an electrical connection is improper; and
ceasing to apply the second voltage to generate the electric fields.

19. The method of claim 15, wherein the threshold value is a predetermined range of value.

20. The method of claim 15, further comprising:
prior to loading the substrate with the substrate cassette, placing the biological sample in
contact with the capture probes on the substrate;
arranging the substrate cassette onto the substrate to align a plurality of apertures of the
substrate cassette with a plurality of regions of the substrate and define the plurality of buffer
25 chambers on the plurality of regions; and
supplying buffers in the plurality of buffer chambers.