CLAIMS

1. A method for functionalizing surface attached microposts to produce a micropost surface for target-specific analyte capture, the method comprising the steps of:

a. providing a micropost processing platform, wherein the micropost processing platform comprises microposts that comprise a silicone-based material; and

b. incorporating one or more functionalizing agents into the silicone-based material of the microposts;

whereby the micropost surface for target-specific analyte capture is produced.

2. The method of claim 1, wherein step 1(b) comprises providing a binding system for binding of a target-specific capture agent, wherein the binding system comprises a generic binding agent and a linking agent.

3. The method of claim 2, wherein the generic binding agent is biotin and the linking agent is an avidin, and wherein the target-specific capture agent is a biotin-conjugate; optionally wherein the avidin is avidin, streptavidin, or neutravidin and/or wherein the biotin-conjugate is a biotinylated antibody (Ab).

4. The method of claim 1 or 2, wherein step 1(b) comprises partially or fully functionalizing the surface-attached microposts; optionally either:

(i) wherein partially or fully functionalizing the surface- attached microposts comprises anchoring one or more functionalizing agents into the silicone- based material of the microposts, optionally wherein the anchoring of the one or more functionalizing agents into the silicone-based material of the microposts comprises grafting, bonding, and/or physio-absorption; or

(ii) wherein partially or fully functionalizing the surface- attached microposts comprises providing the one or more functionalizing agents such that the one or more functionalizing agents sit atop the surface of the microposts.

5. The method of claim 4, wherein the silicone-based material of the microposts comprises PDMS;

optionally wherein the silicone-based material of the microposts comprises one or more amine functional groups, wherein the amine functional group provides an anchor point for

subsequent addition of the one or more functionalizing agents.

6. The method of claim 5, wherein the silicone-based material of the microposts comprises one or more amine functional groups, wherein the amine functional group provides an anchor point for subsequent addition of the one or more functionalizing agents and wherein the one or more functionalizing agents comprise a binding agent and/or a blocking agent, optionally either
(i) wherein a generic binding agent is added into the silicone-based material of the microposts, optionally wherein the generic binding agent comprises a biotin-containing agent; or
(ii) wherein the binding agent is a modified lipid that comprises a biotin binding group, optionally wherein the binding agent is 1,2-dioleoyl-sn-glycero-3-phosphoethanolamine-N-(biotinyl) (Bio Dope), optionally wherein the silicone-based material comprises a polymer matrix, and wherein a swelling agent is used to expand the polymer matrix, optionally wherein the swelling agent is removed, whereby the functionalizing agent becomes entangled and anchored in the polymer matrix.

7. The method of any one of claims 1 to 6, further comprising the steps of:
c. reacting functional groups on the surface-attached microposts with a silanizing reagent to form amine-containing groups, whereby amine modified microposts are produced; and
d. causing a crosslinking chemical reaction to add the one or more functionalizing agents to the surface of the amine modified microposts.

8. The method of claim 7, wherein:
(i) the silanizing agent comprises 3- aminopropyltriethoxysilane (APTES) and/or 3-glycidyloxypropyltrimethoxysilane (GOPTS), and/or wherein step (d) comprises the use of N- hydroxysuccinimide ester (NHS) and/or 1-Ethyl-3-(3-Dimethylaminopropyl)carbodiimide (EDAC);
(ii) step (d) comprises the use of click chemistry to conjugate the functionalizing agent to the surface of the microposts;
(iii) wherein step (d) comprises the use of a silanizing agent that comprises a functionalizing agent, optionally wherein the silanizing agent that comprises a functionalizing agent comprises silane polyethylene glycol (silane PEG), and optionally wherein the functionalizing agent comprises a binding group, and further wherein the binding group is a

biotin, whereby the functionalizing agent comprises silane polyethylene glycol biotin (silane PEG biotin);
(iv) wherein step (d) comprises the use of a plasma activationprocess to generate reactive groups that can be used to anchor the functionalizing agent to the surface of the microposts, optionally wherein the reactive groups comprise hydroxyl groups.

9. The method of claim 7, wherein step (d) comprises passivating the surface of the microposts, wherein passivating the surface of the microposts comprises reacting unbound amine groups with a blocking agent.

10. The method of claim 7, wherein step (d) comprises passivating the surface of the microposts, wherein passivating the surface of the microposts comprises incorporating a blocking agent into the silicone-based material that is used to fabricate the microposts.

11. The method of claim 9 or 10, wherein the blocking agent is selected from the group consisting of: polyethylene glycol (PEG); polyethylene oxide (PEO); a lipid; bovine serum albumin (BSA); polypropylene; and polytetrafluoroethylene (PTFE) optionally wherein a solution of a first functionalization reagent is flowed into the reaction chamber via fluid ports or directly into the gap.

12. The method of claim 11, wherein a solution of a first functionalization reagent is flowed into the reaction chamber via fluid ports or directly into the gap and wherein the first functionalization reagent is a pegylated amine-reactive biotin reagent (N-hydroxysuccinimide ester (NHS))-PEG-biotin, and when the first functionalization reagent is a pegylated amine-reactive biotin reagent (N-hydroxysuccinimide ester (NHS))-PEG-biotin then optionally either: (a) wherein the PEG spacer arm is configured to act as a bottlebrush polymer restricting access to the surfaces of the microposts, whereby non-specific binding to the surfaces of the microposts is reduced; or (b) wherein the first functionalization reaction is performed using the first functionalization reagent and reaction conditions sufficient to provide a density of PEG-biotin binding sites on the surface of the microposts sufficient for subsequent high efficiency capture of a target analyte, optionally wherein the first functionalization reagent is a pegylated amine- reactive biotin reagent, and wherein the reagent reacts with amine groups on surfaces of the modified microposts to form stable amide bonds optionally wherein the chain length of the PEG spacer is selected to provide sufficient

mobility to the terminally bound biotin group; or (c) wherein the PEG spacer arm is configured to have a molecular weight of between 500 and 5000; or (d) wherein the chain length of the blocking PEG molecule is selected to be sufficiently shorter than the chain length of the PEG-biotin binding agent to allow for the mobility of the biotin binding group at the end of the PEG arm.

13. The method of either claim 9 or claim 10, wherein a first functionalization reaction is performed to add a generic binding agent on the surface of the modified microposts.

14. A micropost processing platform comprising microposts that comprise a silicone-based material and configured for performance of the methods of any one of claims 1 to 13.

15. The micropost processing platform of claim 14, wherein:
(A) the micropost processing platform comprises a microfluidics system comprising:
i. at least one microfluidic device comprising a reaction chamber, wherein the reaction chamber comprises a micropost field, wherein the micropost field comprises surface-attached magnetically responsive microposts; and
ii. at least one magnetic-based actuation mechanism provided in close proximity to the magnetically responsive microposts, wherein the at least one magnetic-based actuation mechanism is configured to generate an actuation force sufficient to compel at least some of the magnetically responsive microposts to exhibit motion;
or
(B) wherein the reaction chamber comprises at least one contained microfluidic channel, wherein a defined volume of fluid can be flowed into and out of the micropost processing platform via fluid ports for solution-based functionalization reactions; optionally wherein the reaction chamber comprises multiple microfluidic channels.

16. The micropost processing platform of any one of claims 14 or 15, wherein the method further comprises reacting functional groups on the surface of the silicone-based material of the microposts with APTES to form amine-containing groups on amine modified microposts, followed by the use of one or more amine-ester (NHS) chemical reactions to add one or more functional groups to the surface of the amine modified microposts, optionally wherein the APTES-modification reaction is performed prior to assembly of the microposts processing platform to form a reaction chamber, and wherein the one or more NHS chemical reactions to

add one or more functional groups to the surface of the amine modified microposts are performed in the reaction chamber of the assembled microposts processing platform.

17. The micropost processing platform of any one of claims 14 to 16, comprising:
(i) two facing substrates of functionalized surface-attached microposts; or
(ii) at least two individual microfluidics devices configured as drop-in ready modules for integration into a fluidics cartridge or system of an end user; or
(iii) a pair of opposing substrates of functionalized surface-attached microposts, wherein the pair of opposing substrates are separated by a gap, thereby forming a reaction chamber between the pair of opposing substrates, optionally (a) comprising a spacer or gasket provided between the pair of substrates to form the gap or (b) wherein the height of the gap is from about 50 μm to about 1 mm or (c) configured to allow bulk fluid to be flowed through the reaction chamber by supplying fluid directly to the gap optionally wherein one end of the reaction chamber is an inlet and the other end of the reaction chamber is an outlet, or (d) comprising fluid ports provided in one or both substrates, optionally comprising two fluid ports provided in one substrate, wherein one fluid port is an inlet and the other inlet port is an outlet.

18. The micropost processing platform of any one of claims 14 to 16, comprising:
i. at least one microfluidic device comprising a reaction chamber, wherein the reaction chamber comprises a micropost field, wherein the micropost field comprises surface-attached magnetically responsive microposts; and
ii. at least one magnetic-based actuation mechanism provided in close proximity to the magnetically responsive microposts, wherein the at least one magnetic-based actuation mechanism is configured to generate an actuation force sufficient to compel at least some of the magnetically responsive microposts to exhibit motion; optionally
(A) wherein each of the at least one microfluidic devices comprises a bottom substrate and a top substrate separated by a gap, thereby forming the reaction chamber between the bottom substrate and the top substrate optionally wherein a spacer or gasket is provided between the bottom substrate and top the substrate to form the gap and define the reaction chamber;
(B) wherein the top substrate comprises an inlet port and an outlet port; or
(C) wherein the reaction chamber is sized to hold a desired volume of fluid.

19. The micropost processing platform of claim 18, wherein:

(i) the gap has a height of from about 50 μm to about 1 mm; and/or
(ii) wherein the micropost field is provided on the inner surface of the bottom substrate or wherein the micropost field is provided on the inner surface of the top substrate or wherein the micropost field is provided on both the inner surface of the bottom substrate and the inner surface of the top substrate; and/or
(iii) wherein microposts within the reaction chamber are functionalized with target-specific analyte capture elements, optionally wherein the microposts are functionalized using a surface-functionalization process and optionally wherein surface functionalization of the microposts is performed prior to assembly of the two substrates to form the reaction chamber.

20. The micropost processing platform of any one of claims 16 to 19, comprising opposing microposts, wherein the opposing microposts are configured such that there is no space or gap between the tips of the opposing microposts, optionally wherein the opposing microposts are interdigitated and optionally wherein (i) the interdigitated opposing microposts are configured such that the tips of the opposing microposts are set at different planes such that they overlap, (ii) the tips of a first set of the opposing microposts are set at a plane p1 and the tips of an opposing set of microposts to the first set of microposts are set at a plane p2, (iii) the interdigitated opposing microposts are configured such that the tips of the opposing microposts are set with substantially no overlap, (iv) wherein the tips of the opposing microposts are set at the same plane, or (v) wherein the tips of the opposing microposts are separated by a space or gap, optionally wherein the tips of the opposing microposts are configured such that the space or gap between the tips of the opposing microposts provides a low resistance flow path through the center of the reaction chamber through which targets can travel and not encounter a micropost.