Claims:

1. A functionalized plasmonic nanostructure, comprising:

a plasmonic nanostructure core;

a polymeric hydrogel attached to the plasmonic nanostructure core, the polymeric hydrogel having a thickness ranging from 10 nm to 200 nm;

a plurality of primers attached to side chains or arms of the polymeric hydrogel, wherein at least some of the plurality of primers are attached to the polymeric hydrogel at different distances from the plasmonic nanostructure core; and

a mechanism to anchor the functionalized plasmonic nanostructure to a capture site of a flow cell.

2. The functionalized plasmonic nanostructure as defined in claim 1, wherein:

i) the plasmonic nanostructure core is selected from the group consisting of a gold nanostructure, a silver nanostructure, a tin nanostructure, a rhodium nanostructure, a ruthenium nanostructure, a palladium nanostructure, an osmium nanostructure, an iridium nanostructure, a platinum nanostructure, a chromium nanostructure, a copper nanostructure, a gallium arsenide nanostructure, a doped silicon nanostructure, an aluminum nanostructure, a magnesium nanostructure, a silver and gold composite nanostructure, and combinations thereof;

ii) the polymeric hydrogel includes at least one acrylamide monomer unit; and

the polymeric hydrogel is a linear polymeric hydrogel or a branched polymeric hydrogel; or

iii) the plasmonic nanostructure core is functionalized with an alkyne, and the polymeric hydrogel includes an azide that is attached to the alkyne; or

the plasmonic nanostructure core is functionalized with an azide, and the polymeric hydrogel includes a dialkyne that is attached to the azide.

3. The functionalized plasmonic nanostructure as defined in claim 1, wherein the mechanism is:

i) a magnetic material in the plasmonic nanostructure core;

ii) a functional agent incorporated into to the polymeric hydrogel; or

iii) a reversibly chargeable functional group attached to the polymeric hydrogel.

4. The functionalized plasmonic nanostructure as defined in claim 1, wherein the different distances range from greater than 0 nm to 20 nm.

5. A kit, comprising:

a flow cell including a plurality of capture sites; and

a suspension including:

a liquid carrier; and

a plurality of functionalized plasmonic nanostructures dispersed throughout the liquid carrier, wherein each of the functionalized plasmonic nanostructures includes:

a plasmonic nanostructure core;

a polymeric hydrogel attached to the plasmonic nanostructure core, the polymeric hydrogel having a thickness ranging from 10 nm to 200 nm;

a plurality of primers attached to side chains or arms of the polymeric hydrogel, wherein at least some of the plurality of primers are attached to the polymeric hydrogel at different distances from the plasmonic nanostructure core; and

a mechanism to attach to the capture site of the flow cell.

6. The kit as defined in claim 5, wherein:

i) the plasmonic nanostructure core is selected from the group consisting of a gold nanostructure, a silver nanostructure, a tin nanostructure, a rhodium nanostructure, a ruthenium nanostructure, a palladium nanostructure, an osmium nanostructure, an iridium nanostructure, a platinum nanostructure, a chromium nanostructure, a copper nanostructure, a gallium arsenide nanostructure, a doped silicon nanostructure, an aluminum nanostructure, a magnesium nanostructure, a silver and gold composite nanostructure, and combinations thereof; or

ii) the polymeric hydrogel includes at least one acrylamide monomer unit; and

the polymeric hydrogel is a linear polymeric hydrogel or a branched polymeric hydrogel.

7. The kit as defined in claim 5, wherein:

i) each of the plurality of capture sites is magnetic; and

the mechanism is a magnetic material included in the plasmonic nanostructure core;

ii) each of the plurality of capture sites includes a chemical capture agent; and

the mechanism is a functional agent incorporated the polymeric hydrogel; or

iii) each of the plurality of capture sites includes an electrostatic capture agent; and

the mechanism is a reversibly chargeable functional group attached to the polymeric hydrogel.

8. The kit as defined in claim 5, wherein the different distances range from greater than 0 nm to 20 nm.

9. The kit as defined in claim 5, wherein:

i) the substrate includes depressions separated by interstitial regions; and

at least one of the plurality of capture sites is positioned in each of the depressions;

ii) the substrate includes posts separated by interstitial regions; and

at least one of the plurality of capture sites is positioned over each of the posts; or

iii) the substrate has a substantially flat surface; and

the plurality of capture sites are positioned in a pattern across the substantially flat surface.

10. A flow cell, comprising:

a substrate including a plurality of capture sites; and

functionalized plasmonic nanostructures anchored to at least some of the plurality of capture sites, each functionalized plasmonic nanostructure including:

a plasmonic nanostructure core;

a polymeric hydrogel attached to the plasmonic nanostructure core, the polymeric hydrogel having a thickness ranging from 10 nm to 200 nm;

a plurality of primers attached to side chains or arms of the polymeric hydrogel, wherein at least some of the plurality of primers are attached to the polymeric hydrogel at different distances from the plasmonic nanostructure core; and

a mechanism anchoring the functionalized plasmonic nanostructure to the capture site.

11. The flow cell as defined in claim 10, wherein:

i) each of the plurality of capture sites is magnetic; and

the mechanism is a magnetic material included in the plasmonic nanostructure core; or

ii) each of the plurality of capture sites includes a chemical capture agent; and

the mechanism is a functional agent incorporated the polymeric hydrogel.

12. The flow cell as defined in claim 10, wherein the different distances range from greater than 0 nm to 20 nm.

13. The flow cell as defined in claim 10, wherein:

i) the substrate includes depressions separated by interstitial regions; and

at least one of the plurality of capture sites is positioned in each of the depressions;

ii) the substrate includes posts separated by interstitial regions; and

at least one of the plurality of capture sites is positioned over each of the posts; or

iii) the substrate has a substantially flat surface; and

the plurality of capture sites is positioned in a pattern across the substantially flat surface.

14. A method, comprising:

preparing a plurality of functionalized plasmonic nanostructures, wherein each of the functionalized plasmonic nanostructures includes:

a plasmonic nanostructure core;

a polymeric hydrogel attached to the plasmonic nanostructure core, the polymeric hydrogel having a thickness ranging from 10 nm to 200 nm;

a plurality of primers attached to side chains of the polymeric hydrogel, wherein at least some of the plurality of primers are attached to the polymeric hydrogel at different distances from the plasmonic nanostructure core; and

a mechanism to attach to a capture site of a flow cell; and

dispersing the functionalized plasmonic nanostructures throughout a liquid carrier.

15. The method as defined in claim 14, wherein preparing the functionalized plasmonic nanostructures involves:

copolymerizing monomers to form the polymeric hydrogel;

grafting the primers to the polymeric hydrogel to generate a pre-grafted polymeric hydrogel; and

coating the pre-grafted polymeric hydrogel on the plasmonic nanostructure core.

16. The method as defined in claim 15, further comprising incorporating the mechanism after the polymeric hydrogel is formed.

17. The method as defined in claim 14, wherein preparing the functionalized plasmonic nanostructures involves:

copolymerizing a first monomer and a second monomer in the presence of the plasmonic nanostructure core to form the polymeric hydrogel, the first monomer having a first functional group to attach to the primer and the second monomer having a second functional group to attach to an anchoring surface group on the plasmonic nanostructure core;

quenching polymerization when the thickness is achieved; and

grafting the primers to the polymeric hydrogel.

18. The method as defined in claim 17, further comprising incorporating the mechanism after the polymeric hydrogel is formed.

19. A method, comprising:

introducing a template nucleic acid strand to a plasmonic enhancing suspension, the plasmonic enhancing suspension including:

a liquid carrier; and

a plurality of functionalized plasmonic nanostructures dispersed throughout the liquid carrier, wherein each of the functionalized plasmonic nanostructures includes:

a plasmonic nanostructure core;

a polymeric hydrogel attached to the plasmonic nanostructure core, the polymeric hydrogel having a thickness ranging from 10 nm to 200 nm;

a plurality of primers attached to side chains or arms of the polymeric hydrogel, wherein at least some of the plurality of primers are attached to the polymeric hydrogel at different distances from the plasmonic nanostructure core; and

a mechanism to attach to a capture site of a flow cell;

initiating amplification of the template nucleic acid strand on the functionalized plasmonic nanostructures to form functionalized plasmonic nanostructures with a cluster of the template nucleic acid strands; and

introducing the functionalized plasmonic nanostructures with the cluster of the template nucleic acid strands into a flow cell including a plurality of the capture sites, whereby at least some of the functionalized plasmonic nanostructures respectively attach to at least some of the capture sites.