independently a C1-C6 alkyl and -SHR^+, SR_2^+, -SO_3^-, -PO_4^-, -NH_3^+, -NH_2R^+, -NHR_2^+ ,-NR_3^+, ethynyl, or -N_3, each optionally has an associated counterion; and

n is an integer from 1 to about 1,000.

In one embodiment, there is provided a method of detecting an analyte, comprising:

contacting an analyte with a cognate ligand under conditions which promote binding of the analyte to the cognate ligand;

contacting the analyte bound to the cognate ligand with a polymer as defined above under conditions that promote binding of the polymer to the analyte;

exciting a fluorescent signal in the polymer bound to the analyte; and

detecting the fluorescent signal emitted by the polymer.

In one embodiment, there is provided a device for detecting an analyte, comprising:

a substrate;

a solid support material disposed on the substrate;

a ligand, attached to the solid support material, said ligand being cognate to an analyte being detected; and

a polymer as defined above, capable of binding to the analyte bound to the cognate ligand.

In one embodiment, there is provided a kit for detecting an analyte, comprising:

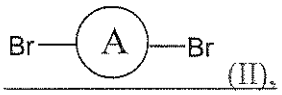
a substrate;

a solid support material;

a ligand capable of being attached to the solid support material, said ligand being cognate to an analyte being detected; and

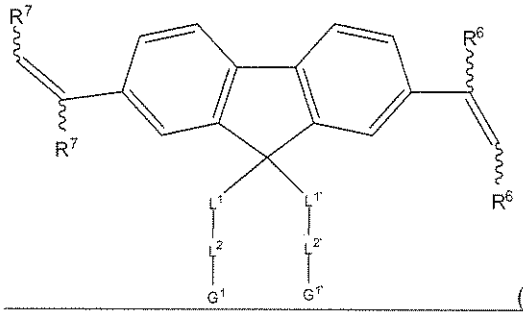
a polymer as defined above, capable of binding to the analyte bound to the cognate ligand.

In one embodiment, there is provided a method of preparing a polymer represented by formula (I), comprising reacting a compound of formula (II)



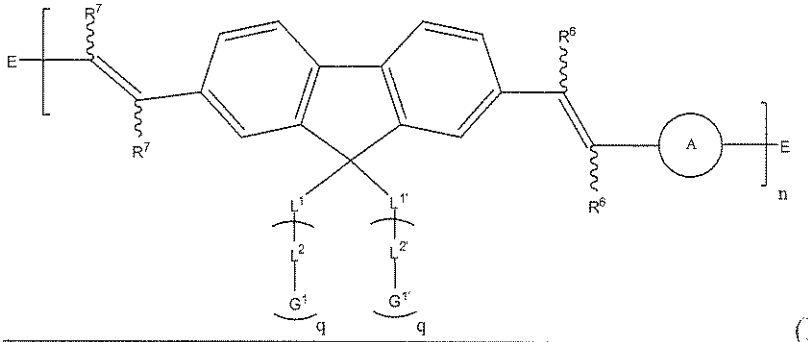
(II),

with a compound of formula (III)



(III),

thereby producing a polymer represented by the following formula:



(I),

wherein:

E, for each occurrence, is independently a trialkylsiloxy or an aryl group optionally substituted with a reactive group or a pendent reactive group capable of undergoing chain extension, conjugation, or crosslinking;

A is an aryl or a heteroaryl, optionally substituted with one or more substituents selected from halogen, hydroxyl, C1-C12 alkyl, C2-C12 alkene, C2-C12 alkyne, C3-C12 cycloalkyl, C1-C12 haloalkyl, C1-C12 alkoxy, C6-C18 (hetero)aryloxy, C6-C18 (hetero)arylamino, a C6-C18 (hetero)aryl group and an ethylene glycol polymer; wherein the substituents for ring A are not ammonium group;

L^1, $L^{1'}$, L^2 and $L^{2'}$ are each independently a covalent bond, a C1-C12 alkylene, a C3-C12 cycloalkylene, a C2-C12 alkenylene, a C2-C12 alkynylene, a (C6-C18)aryl(C1-C12)alkylene, a (C6-C18)aryl(C2-C12)alkenylene, a (C6-C18)aryl(C1-C12)alkynylene, a C6-C18 arylene group, $-Y_1-[O-Y_2]_p-$, $-O-Y_1-[O-Y_2]_p-$ wherein each C1-C12 alkylene, C3-C12 cycloalkylene, (C6-C18)aryl(C1-C12)alkylene, or C6-C18 arylene group is optionally substituted with one or more halogen, hydroxyl, C1-C12 alkyl, C2-C12 alkenyl, C2-C12 alkynyl group, C1-C12 alkoxy, C1-C12 haloalkyl, $-Y_1-[O-Y_2]_p-$ or $-O-Y_1-[O-Y_2]_p-$;

q is 0 or an integer from 1 to 8;

p is 0 or an integer from 1 to 24;

Y_1 and Y_2 are each independently a covalent bond, or a C1-12 alkylene group, a C3-C12 cycloalkylene, a C6-C18 (hetero)arylene, a (C6-C18)aryl(C1-C12)alkylene, wherein each C1-12 alkylene group, C3-C12 cycloalkylene, C6-C18 (hetero)arylene, (C6-C18)aryl(C1-C12)alkylene is optionally substituted with one or more halogen, hydroxyl, C1-C12 alkyl, C2-C12 alkenyl, C2-C12 alkynyl group, C1-C12 alkoxy, or C1-C12 haloalkyl;

each R^6 and R^7 is independently hydrogen, C1-C12 alkyl, C2-C12 alkene, C2-C12 alkyne, C3-C12 cycloalkyl or a C6-C18 (hetero)aryl group, wherein each C1-C12 alkyl, C2-C12 alkene, C2-C12 alkyne, C3-C12 cycloalkyl or a C6-C18 (hetero)aryl group is optionally substituted with one or more halogen, hydroxyl, C1-C12 alkyl, C2-C12 alkenyl, C2-C12 alkynyl group, C1-C12 alkoxy, C1-C12 haloalkyl, cyano, or C2-C12 (hetero)alkynl;

G^1 and $G^{1'}$ are each independently, hydrogen, C1-C6 alkyl, -OH, -OR, -COOH, -SH, -SR, $-SHR^+$, $-SR_2^+$, $-SO_3^-$, $-PO_4^-$, -Br, $-NH_2$, -NHR, $-NR_2$, $-NH_3^+$, $-NH_2R^+$, $-NHR_2^+$ or $-NR_3^+$, wherein each R is independently a C1-C6 alkyl and $-SHR^+$, SR_2^+, $-SO_3^-$, $-PO_4^-$, $-NH_3^+$, $-NH_2R^+$, $-NHR_2^+$ or $-NR_3^+$ each optionally has an associated counterion; and

n is an integer from 1 to about 1,000.

In one embodiment, there is provided a method of detecting an analyte, comprising:

contacting an analyte with a cognate ligand under conditions which promote binding of the analyte to the cognate ligand;

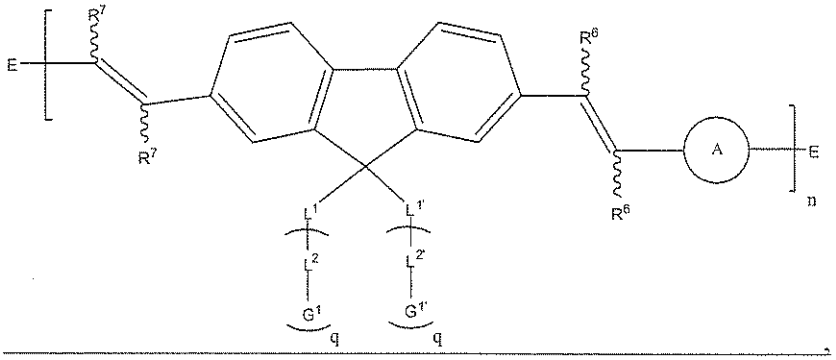
contacting the analyte bound to the cognate ligand with a polymer under conditions that promote binding of the polymer to the analyte;

exciting a fluorescent signal in the polymer bound to the analyte; and

detecting the fluorescent signal emitted by the polymer,

wherein the cognate ligand is optionally attached to a solid support material; and

wherein the polymer comprises a repeat unit represented by the following formula:



wherein:

E, for each occurrence, is independently a trialkylsiloxy or an aryl group optionally substituted with a reactive group or a pendent reactive group capable of undergoing chain extension, conjugation, or crosslinking;

A is an aryl or a heteroaryl, optionally substituted with one or more substituents selected from halogen, hydroxyl, C1-C12 alkyl, C2-C12 alkene, C2-C12 alkyne, C3-C12 cycloalkyl, C1-C12 haloalkyl, C1-C12 alkoxy, C6-C18 (hetero)aryloxy, C6-C18 (hetero)arylamino, a C6-C18 (hetero)aryl group and an ethylene glycol polymer; wherein the substituents for ring A are not ammonium group;

L^1, $L^{1'}$, L^2 and $L^{2'}$ are each independently a covalent bond, a C1-C12 alkylene, a C3-C12 cycloalkylene, a C2-C12 alkenylene, a C2-C12 alkynylene, a (C6-C18)aryl(C1-C12)alkylene, a (C6-C18)aryl(C2-C12)alkenylene, a (C6-C18)aryl(C1-C12)alkynylene, a C6-C18 arylene group, $-Y_1-[O-Y_2]_p-$, $-O-Y_1-[O-Y_2]_p-$ wherein each C1-C12 alkylene, C3-C12 cycloalkylene, (C6-C18)aryl(C1-C12)alkylene, or C6-C18 arylene group is optionally substituted with one or more halogen, hydroxyl, C1-C12 alkyl, C2-C12 alkenyl, C2-C12 alkynyl group, C1-C12 alkoxy, C1-C12 haloalkyl, $-Y_1-[O-Y_2]_p-$ or $-O-Y_1-[O-Y_2]_p-$;

q is 0 or an integer from 1 to 8;

p is 0 or an integer from 1 to 24;

Y_1 and Y_2 are each independently a covalent bond, or a C1-12 alkylene group, a C3-C12 cycloalkylene, a C6-C18 (hetero)arylene, a (C6-C18)aryl(C1-C12)alkylene, wherein each C1-12 alkylene group, C3-C12 cycloalkylene, C6-C18 (hetero)arylene, (C6-C18)aryl(C1-C12)alkylene is optionally substituted with one or more halogen, hydroxyl, C1-C12 alkyl, C2-C12 alkenyl, C2-C12 alkynyl group, C1-C12 alkoxy, or C1-C12 haloalkyl;

each R^6 and R^7 is independently hydrogen, C1-C12 alkyl, C2-C12 alkene, C2-C12 alkyne, C3-C12 cycloalkyl or a C6-C18 (hetero)aryl group, wherein each C1-C12 alkyl, C2-C12 alkene, C2-C12 alkyne, C3-C12 cycloalkyl or C6-C18 (hetero)aryl group is optionally substituted with one or more halogen, hydroxyl, C1-C12 alkyl, C2-C12 alkenyl, C2-C12 alkynyl group, C1-C12 alkoxy, C1-C12 haloalkyl, cyano, or C2-C12 (hetero)alkynl;

G^1 and $G^{1'}$ are each independently, hydrogen, C1-C6 alkyl, -OH, -OR, -COOH, -SH, -SR, $-SHR^+$, $-SR_2^+$, $-SO_3^-$, $-PO_4^-$, -Br, $-NH_2$, -NHR, $-NR_2$, $-NH_3^+$, $-NH_2R^+$, $-NHR_2^+$ or $-NR_3^+$, wherein each R is independently a C1-C6 alkyl and $-SHR^+$, SR_2^+, $-SO_3^-$, $-PO_4^-$, $-NH_3^+$, $-NH_2R^+$, $-NHR_2^+$ or $-NR_3^+$ each optionally has an associated counterion; and

n is an integer from 1 to about 1,000.

In one embodiment, there is provided a method of conjugating a polymer to a dye or a biomolecule, comprising:

Modifying a dye or a biomolecule with a succinimidyl linker;

Modifying a polymer as defined above with a hydrazine linker; and

contacting and reacting the modified dye or a biomolecule with the modified polymer to produce a polymer conjugated to the dye or biomolecule.

BRIEF DESCRIPTION OF THE DRAWINGS

The patent or application file contains at least one drawing executed in color. Copies of this patent or patent application publication with color drawing(s) will be provided by the Office upon request and payment of the necessary fee.

The foregoing will be apparent from the following more particular description of example embodiments of the invention, as illustrated in the accompanying drawings in which like reference characters refer to the same parts throughout the different views. The drawings are not necessarily to scale, emphasis instead being placed upon illustrating embodiments of the present invention.

FIG. 1 is a scheme to pattern polystyrene beads on silicon wafer.

FIG. 2 is a scheme of the patterning chamber (made of PMMA) for beads self-assembly in the well. The dimension of the sunk part is 65 × 22 × 2 mm (length × width × depth).

FIG. 3 shows SEM images for patterned PS beads.

FIG. 4 depicts bead array fabrication scheme (A) and the detection schemes for labeled target (B) and label-free target (C). For DNA detection, the probe can be DNA or PNA in scheme A. In scheme B, ssDNA (black) is used as the probe, complementary DNA (blue) and non- complementary DNA (green) are labeled with Cy5 (red) to serve as the targets. For scheme B, PNA could also serve as the probe for labeled DNA detection. In scheme C, PNA (brown) is used as the probe, and complementary DNA (blue) or non-complementary DNA (green) is served as the target.

FIG. 5 is a plot showing the absorption and emission spectra of cationic conjugated polymers in solution. Panels A and B are the spectrum and structure of PFOBT. C and D are the spectrum and structure of polymer PFVP.

FIG. 6 is a plot showing the absorption and emission spectra of PFVP in solid state.

FIG. 7 (top) is a plot showing the emission spectra for solutions upon direct excitation of Cy5 at 649 nm in the absence of the polymer (black line) and that upon excitation of the polymer (dashed line) at 408 nm in 10mM PBS buffer. In this figure, the concentration of the cy5-labeled 20 mer DNA is $5*10^{-9}$M. The polymer emission does not interfere with the Cy5 emission. Excitation at 408 nm gives slightly better results as compared to that at 457 nm. (Bottom), same experiment with additional dyes, Cy3 and Alexa 750.

FIG. 8 shows confocal images of polymer amplified bead array for DNA detection. A) one-dimensional image; B) Intensity value for any four dots in a line; C) three-dimensional image. The DNA concentration used for hybridization is 1×10^{-6} M.

FIG. 9 shows fluorescence images of a planar surface after probe immobilization and Cy-5 DNA hybridization (A), PS bead patterning after hybridization of cy5 labeled target DNA without applying the