CLAIMS

We Claim:

1. A sensor, comprising:

a substrate configured with at least one depression in the substrate;

an insulator in the at least one depression in the substrate and configured to form at least two openings to the substrate, the insulator overlying sides of the at least one depression to form the at least two openings;

a ~~having~~ first epitaxial crystalline structure in at least a portion of a first of the at least two openings;

~~and~~ a second epitaxial crystalline structure in at least a portion of a second of the at least two openings, the first and second epitaxial crystalline structures interfacing at a coalesced portion;

a sensing region formed at or in the coalesced portion to output electrons generated by light absorption therein; and

contacts coupled to receive the electrons to obtain an output electric signal.

2. The sensor of claim 1, wherein the first or the second epitaxial crystalline structure is substantially free from dislocation defects.

3. The sensor of claim 1, wherein the first or the second epitaxial crystalline structures is comprised of a semiconductor material.

4. The sensor of claim 1, ~~wherein the first and second epitaxial crystalline structures are disposed in first and second openings,~~ wherein the at least two openings include~~are~~ trenches formed in a crystalline substrate.

~~5. The sensor of claim 1, wherein the first and second epitaxial crystalline structures are disposed in first and second openings, wherein the openings are formed within a dielectric layer comprised of a dielectric material over a crystalline substrate.~~

~~6~~5. The sensor of claim 1, wherein the sensing region comprises a ***p-n*** junction or a ***p-i-n*** structure.

~~7~~6. The sensor of claim 1, wherein the sensor is a photodetector pixel of a semiconductor device; the photodetector pixel is a complementary-metal-oxide-semiconductor photodetector; and the photodetector comprises a ***p-n*** junction or a ***p-i-n*** structure and a metal-oxide-semiconductor transistor, wherein the ***p-n*** junction or a ***p-i-n*** structure is formed in the sensing region, and wherein the photodetector is an IR or UV detector.

~~8~~7. The sensor of claim 1, wherein the coalesced portion has a width of 1 micron or larger, the width of 2 microns or larger~~, the width from 2 to 5 microns or the width of 5 microns or larger~~.

~~9~~8. The sensor of claim 1, comprising:

a **p-i-n** structure formed within the substrate; and

an intrinsic region of the p-i-n structure is positioned to receive light in the sensing region.

~~10~~9. The sensor of claim 1, wherein each of the first and second epitaxial crystalline structures are ~~coalesced over an insulator configured to form at least two openings to a~~ lattice mismatched to the~~crystalline~~ substrate~~, the first and second structures in at least a portion of a corresponding one of said at least two openings~~.

~~11~~10. The sensor of claim ~~10~~9, wherein ~~the substrate is configured with depressions in the substrate, and wherein the insulator overlies sides of the depression to form said openings and the~~an aspect ratio of at least one of the at least two opening is ~~1 or greater or the aspect ratio of the opening is~~ 0.5 or greater, wherein each of the openings is a trench, recess or hole.

~~12~~11. The sensor of claim ~~10~~9, wherein ~~the substrate is configured with depressions in the substrate, and wherein the insulator overlies sides of the depression to form said openings and~~ each of said first and second epitaxial crystalline structures comprise an epitaxial lateral overgrowth (ELO) region, wherein said ELO region is at least 2 times a width of the opening~~, at least 5 times the width of the opening or at least 10 times~~

~~the width of the openings~~.

~~13~~12. The sensor of claim 1, wherein the first and second epitaxial crystalline structures comprise~~materials are~~ semiconductor materials among a group II-VI compound, a group III-V compound, group III-N compound or ternary and quaternary compounds thereof or a group IV material.

~~14~~13. A method, comprising:

providing a crystalline semiconductor substrate;

forming at least one depression~~a first trench patterned structure~~ in the substrate;

forming ~~a second trench patterned structure in the first trench patterned structure, wherein the second trench patterned structure has a width equal to or less than the width of the first trench patterned structure~~an insulator in the at least one depression in the substrate and configured to form at least two openings to the substrate, the insulator overlying sides of the at least one depression to form the at least two openings; ~~and~~

forming a first epitaxial crystalline structure in at least a portion of a first of the at least two openings;

forming ~~an ART (aspect ratio trapping) material in the first and second trench patterned~~ a second epitaxial crystalline structure in at least a portion of a second of the at least two openings, the first and second epitaxial crystalline structures interfacing at a coalesced portion; and

making a photodetector formed at or in the ~~ART material~~ coalesced portion to output electrons generated by light absorption therein.

~~15~~14. The method of claim ~~14~~13, wherein the substrate is a silicon substrate; and the ~~ART material is~~ first and second epitaxial crystalline structures are comprised of a non-silicon semiconductor material.

~~16~~15. The method of claim ~~14~~13, wherein the ~~first trench patterned structure~~ at least one depression has a width of 2 microns or larger~~ or the width of 5 microns~~.

~~17~~16. The method of claim ~~14~~13, wherein ~~forming the ART material comprises~~

~~growing~~ each of the first and second epitaxial crystalline ~~material~~ structures are lattice-mismatched to the crystalline semiconductor substrate.

~~18~~17. A semiconductor sensor, comprising:

a crystalline substrate having a recessed portion from a top surface of the crystalline substrate;

an insulator in the recessed portion of the crystalline substrate, the insulator having a plurality of openings to the crystalline substrate in the recessed portion;

a first crystalline material within the openings in the insulator, the first crystalline material being lattice-mismatched with the substrate;

a second different buffer crystalline material being lattice-mismatched with the crystalline substrate between the crystalline substrate and the first crystalline material;

a light-sensing device in a least a portion of the first crystalline material to output electrons generated by light absorption therein; and

contacts coupled to receive the electrons generated by light absorption to obtain an output electric signal.

~~19~~18. The sensor of claim ~~18~~17, wherein the second different buffer crystalline material has a thickness over the substrate less than 100nm~~, less than 60nm, less than 40nm, less than 20nm or less than 10nm~~.

~~20~~19. The sensor of claim ~~18~~17, wherein the first crystalline material comprises a group II-VI compound or ternary and quaternary compounds thereof, a group III-V compound or ternary and quaternary compounds thereof, group III-N compound or ternary and quaternary compounds thereof or a group IV material.