CLAIMS

1. A microfluidics system comprising:
   (a) a microfluidics instrument, wherein the microfluidics instrument includes an optical detection system;
   (b) a microfluidics cartridge; and
   (c) a self-aligning optical fiber system;
   wherein the self-aligning optical fiber system optically couples the microfluidics instrument and the microfluidics cartridge.

2. The microfluidics system of claim 1, wherein the self-aligning optical fiber system comprises an instrument fiber optic coupler and a cartridge fiber optic connector.

3. The microfluidics system of any preceding claim, wherein the optical detection system comprises an illumination source and an optical measurement device.

4. The microfluidics system of any preceding claims, wherein the self-aligning optical fiber system comprises a plurality of optical detection channels, and wherein each of the plurality of optical detection channels comprises an instrument optical channel and a cartridge optical channel;
optionally wherein each of the instrument optical channels optically connects each of the cartridge optical channels to the optical measurement device;
and/or optionally wherein the self-aligning optical fiber system comprises from about 4 to about 16 optical detection channels.

5. The microfluidics system of any one of claims 2-4, wherein the instrument fiber optic coupler comprises a plurality of instrument ferrule assemblies each comprising a leading tip end and an instrument optical fiber; and/or
wherein the cartridge fiber optic connector further comprises a plurality of cartridge ferrule assemblies each comprising a receiving end capable of receiving the instrument ferrule assembly and each comprising a cartridge optical fiber.

6. The microfluidics system of any preceding claim, wherein the microfluidics instrument further comprises a movable slide mechanism, and wherein the movable slide mechanism is operable to create an optical coupling between the microfluidics instrument and the microfluidics cartridge by engaging the instrument fiber optic coupler with the cartridge fiber optic connector; optionally either (i) wherein the movable slide mechanism is operable to engage the instrument ferrule assembly to the cartridge ferrule assembly and thereby coupling the instrument optical fibers to the cartridge optical fibers, or
(ii) wherein the movable slide mechanism comprises a slidable base plate mounted on a rail, a backplate mounted on the end of slidable base plate, a leadscrew and associated motor operable to advance and/or retract the instrument fiber optic coupler with respect to the cartridge fiber optic connector.

7. The microfluidics system of any preceding claim, wherein the microfluidic cartridge further comprises:

(a) a bottom substrate, wherein the bottom substrate comprises a droplet operations surface;

(b) a top substrate; and

wherein the bottom substrate and the top substrate are separated by a droplet operation gap therebetween;

optionally wherein the bottom substrate and/or top substrate comprise a PCB substrate, a glass substrate or a silicon substrate, and wherein the PCB substrate, glass substrate, or silicon substrate is optionally coated with a dielectric layer and one or more electrodes operable for droplet operations; and/or

optionally wherein the droplet operation gap between the bottom substrate and the top substrate is filled with a filler fluid, optionally wherein the filler fluid is a low-viscosity oil or a halogenated oil.

8. The microfluidics system of any preceding claim, wherein the microfluidics cartridge is a digital microfluidics cartridge (DMF).

9. The microfluidics system of any one of claims 3-8, wherein the optical detection system comprises one or more surface plasmon resonance (SPR) sensors or one or more localized surface plasmon resonance (LSPR) sensors.

10. A method for performing an optical detection operation, the method comprising:

(a) providing a microfluidics system, wherein the microfluidics system comprises a microfluidics instrument, a microfluidics cartridge and a plurality of optical detection channels, wherein:

(i) the microfluidics instrument comprises an instrument fiber optics coupler; and

(ii) the microfluidics cartridge comprises a cartridge fiber optics connector;

(b) performing a first optical alignment step to align the instrument fiber optic coupler to the cartridge fiber optic connector;

(c) performing a second optical alignment step to individually align each optical detection channel; and

(d) performing an optical detection operation using the microfluidics system, microfluidics instrument and microfluidics cartridge.

11. The method of claim 10, wherein the microfluidic instrument further comprises a movable slide mechanism, and wherein the first optical alignment step is carried out by moving the movable slide mechanism until the fiber optics coupler engages the fiber optics connector;

optionally wherein the fiber optics coupler is moved towards a stationary fiber optics connector.

12. The method of any one of claims 10-11, wherein the first optical alignment step results in a course alignment of each of the plurality of optical detection channels.

13. The method of any one of claims 11-12, wherein the second alignment step is carried out by continuing to translate the movable slide mechanism towards the microfluidics cartridge until the fiber optics coupler fully engages the fiber optics connector, and thereby individually aligning each of the optical detection channels;

optionally wherein the second optical alignment step results in a fine alignment of each of the plurality of optical detection channels.

14. The method of claim and one of claims 11-13, wherein the fiber optics coupler further comprises a plurality of instrument ferrule assemblies each comprising a leading tip end and an instrument optical fiber, wherein the fiber optics connector further comprises a plurality of cartridge ferrule assemblies each comprising a receiving end capable of receiving the instrument ferrule assembly and each comprising a cartridge optical fiber, and wherein the movable slide is moved until each of the instrument ferrule assemblies engages each of the cartridge ferrule assemblies, thereby connecting the instrument optical fibers with the cartridge optical fibers and creating the plurality of optical detection channels.

15. The method of any one of claims 11-14, wherein the instrument fiber optic coupler further comprises a housing having one or more dowel pins, wherein the cartridge optic connector further comprises a housing having one or more datum holes and wherein the one or more datum holes accept the one or more dowel pins during the first alignment step;
optionally either (i) wherein the dowel pins align instrument fiber optic coupler to cartridge fiber optic connector;
or (ii) wherein the instrument optical fibers are aligned to within about +/- 0.7 mm of cartridge optical fibers.

16. The method of any one of claims 11-15, wherein the second alignment step results in z-direction alignment between the fiber optics coupler and fiber optics connector.

17. The method of any one of claims 14-15, wherein the second alignment step results in direction alignment between each of the instrument ferrule assemblies and each of the cartridge ferrule assemblies and aligns the instrument optical fibers and the cartridge optical fibers face-to-face substantially without leaving any gap therebetween;
optionally wherein the instrument ferrule assembly further comprises a spring and wherein the spring aligns the instrument optical fibers and the cartridge optical fibers face-to-face substantially without leaving any gap therebetween;
and/or optionally wherein the instrument optical fibers are aligned to within about +/- 50 µm of cartridge optical fibers.

18. The method of any one of claims 14-17, wherein an optic gel is applied between the instrument optical fibers and the cartridge optical fibers.

19. The method of any one of claims 10-18, wherein the microfluidics system further comprises an optical detection system comprising an illumination source and an optical measurement device;
optionally wherein the optical detection system comprises surface plasmon resonance (SPR) or localized surface plasmon resonance (LSPR), and wherein the optical detection system comprises an SPR or LSPR illumination source and one or more SPR or LSPR optical measurement devices.

20. The method of any one of claims 10-19, wherein the microfluidics cartridge is a digital microfluidics cartridge (DMF).