- Supporting Information -

Integrated on-site collection and detection of airborne microparticle for a smartphone based microclimate quality control

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Table S1. Comparison of analytical performance of microfluidic devices

	Collection	Detection	Target Particles	Sensitivity	Specificity	Speed	POC*
Microfluidic Concentuaror [1]	Liquid Sample Enrichment in staggered herringbone mixer	Fluoresce staining detection	Liquid *E. coli* (Aq) *Mycobacterium smegmatis* (Aq)	50 CFU/mL	No	1 hour	No Microscope
Microfluidic focusing [2]	Liquid Sample Microfluidic focusing and Fluoresce staining detection	Fluoresce staining detection	Airborne *E. coli*, *Bacillus subtilis,* *Staphylococcus*	~ 5,000 CFU/mL	No	Real-time excluding dye staining process	No Flow cytometry
Quartz Crystal Microbalance, QCM [3]	Liquid Sample Microfluidic focusing	QCM	Liquid Vaccinia viruses (Aq)	40 particles/mL	No	Real-time detection	No QCM
Mass spectrometer [4]	Liquid Sample Paper	Mass spectrometer	Liquid *P. aeruginosa* *S. aureus* *B. subtilis*	10^9CFU/mL	Partially YES	24 hours	No Portable Mass Spectrometer

***POC: Availability of Point of Care device**

Table S2. Boundary conditions for iAC and biochip simulations

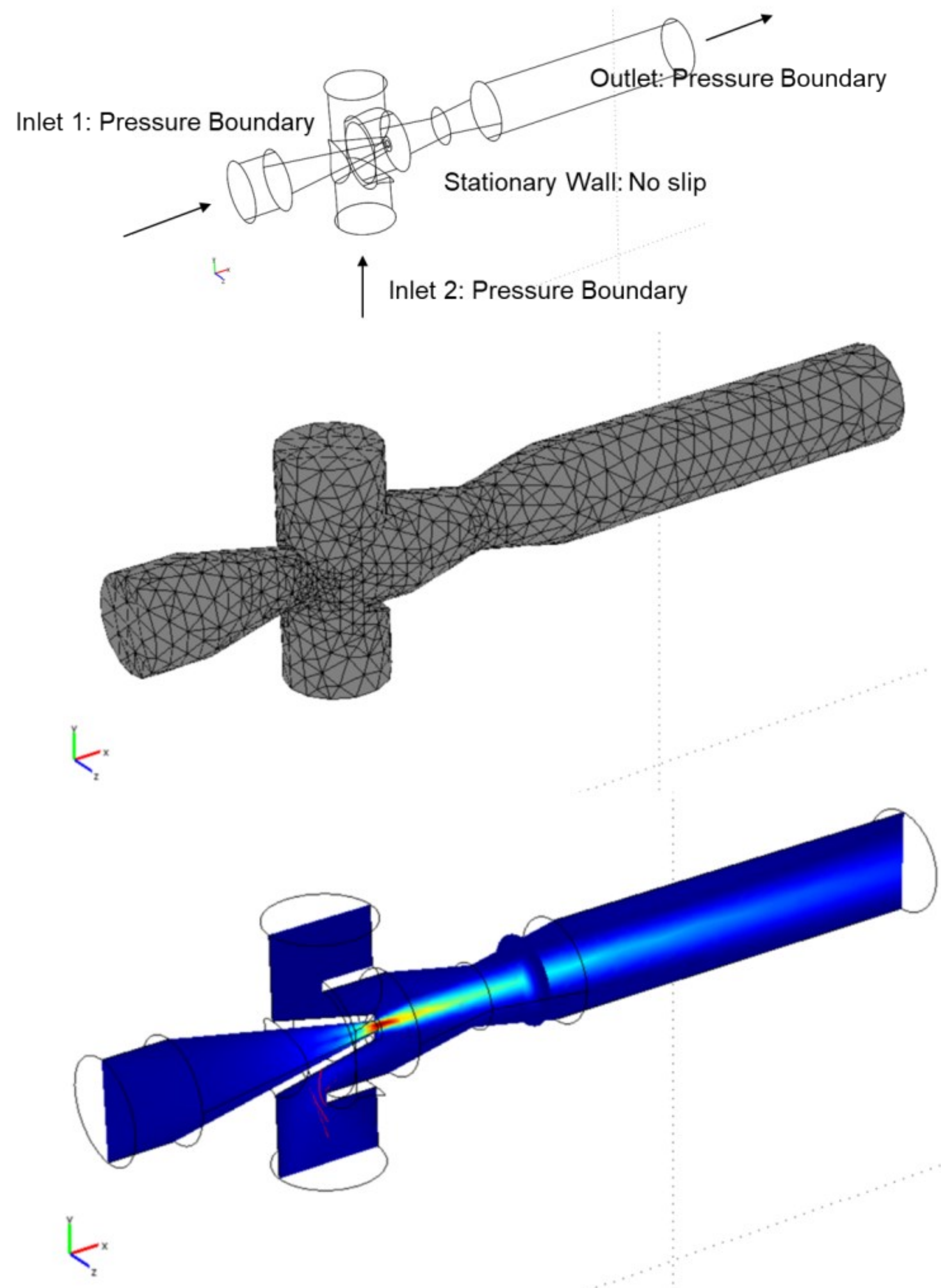
iAC			
Boundary	Condition	Description	Values
Inlet 1	Pressure Boundary No viscous stress	p_{air}	0.1 MPa
Inlet 1	Pressure Boundary No viscous stress	p_{sample}	0 MPa
Outlet	Pressure Boundary No viscous stress	P_{out}	-
Wall	Stationary Wall No slip	*Wall*	0 MPa

Biochip			
Boundary	Condition	Description	Values
Inlet	Velocity Boundary No viscous stress	U_{int}	From 10^{-4} to 10^{2} m/sec
Outlet	Velocity Boundary No viscous stress	U_{out}	0
Wall	Stationary Wall No slip	*Wall*	-

Table S3. List of target airborne pathogens

Size (μm)	Shape	Surface Charge (mV)		Gram negative/ positive
~ 1	Rod	- 21.9	*E. coli*	Gram Negative
~ 1	Sphere	- 9.6	*Micrococcus luteus*	Gram Positive
~ 1	Rod	-75	*Bacillus subtilis*	Gram Positive
~ 10	Aggregated Spheres	- 40	*Staphylococcus aureus*	Gram Positive

a



b

c

Figure S1. 3D finite element analysis of iAQ. a) Geometry with boundary conditions, b) Computational mesh structure with 296,008 cells, and c) A representative result showing velocity profile and particle trajectory.

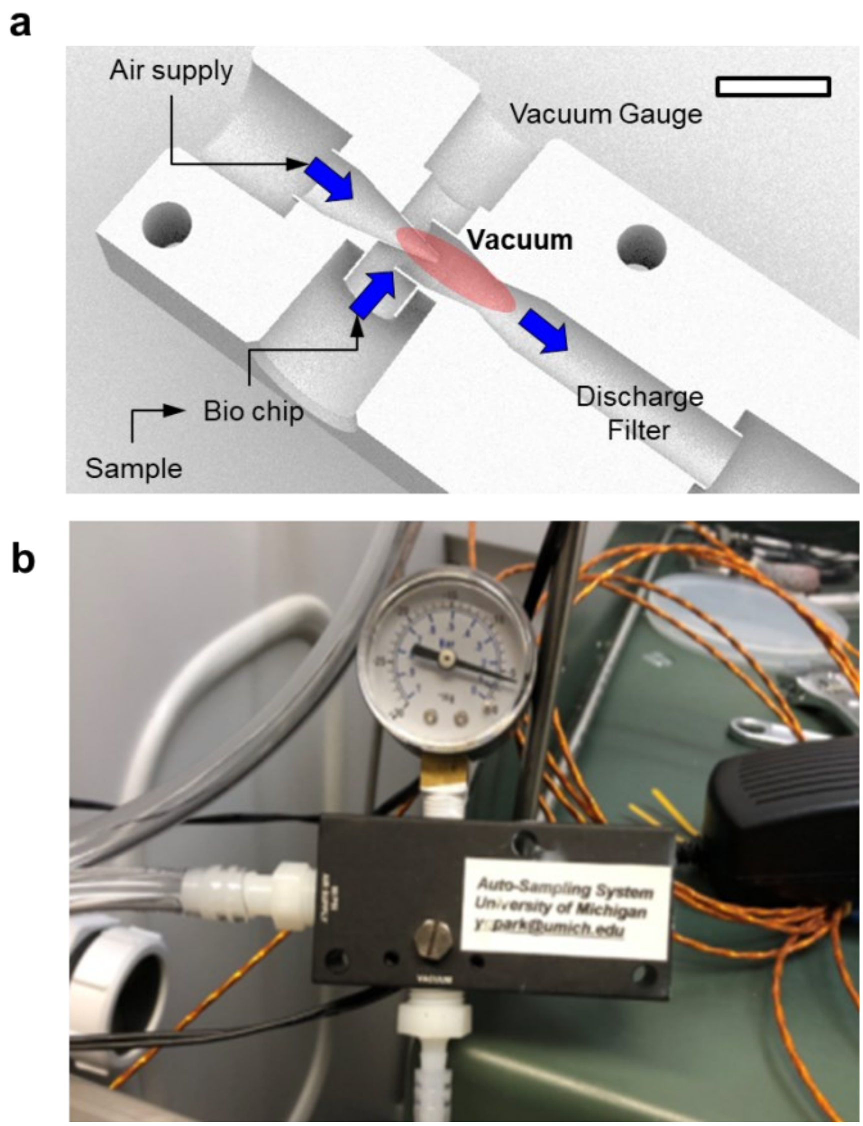
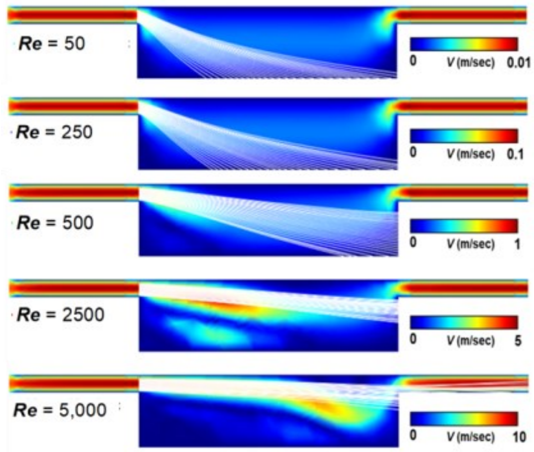


Figure S2. iAC construction and operation: a) Cross-sectional image of the iAC (Scale = 1cm) and b) Constructed iAC with a measurement gauge.

a



b

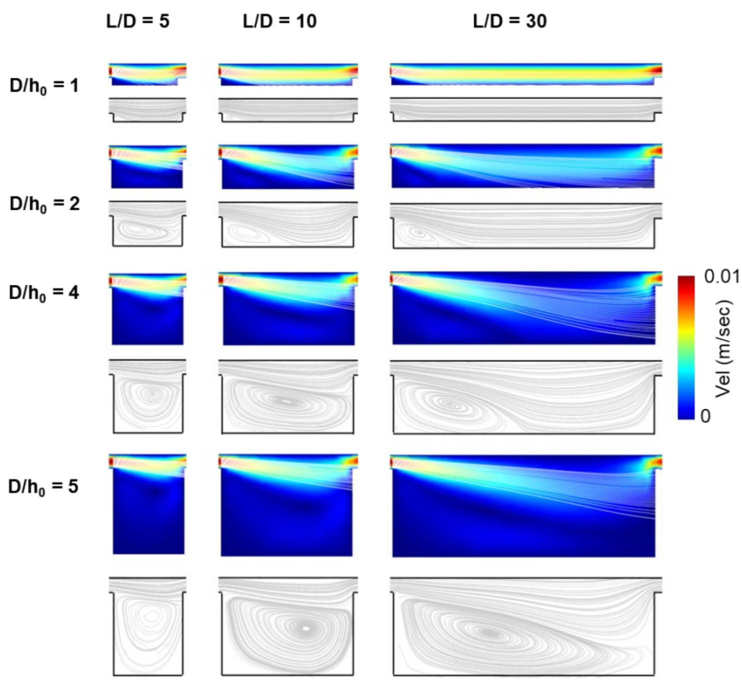


Figure S3. FEA of the biochip showing the particle separation performance of the biochip. (a) Geometry effect on velocity distribution, particle (Diameter = 1μm) trajectory (white line) and stream line (grey curves) at V_{inlet} = 0.01 m/sec in the biochip. (a) Particle trajectory and velocity field as a function of *Re* from 5 to 5,000 in the biochip (d_p = 1μm, L = 12 mm and d = 4 mm).

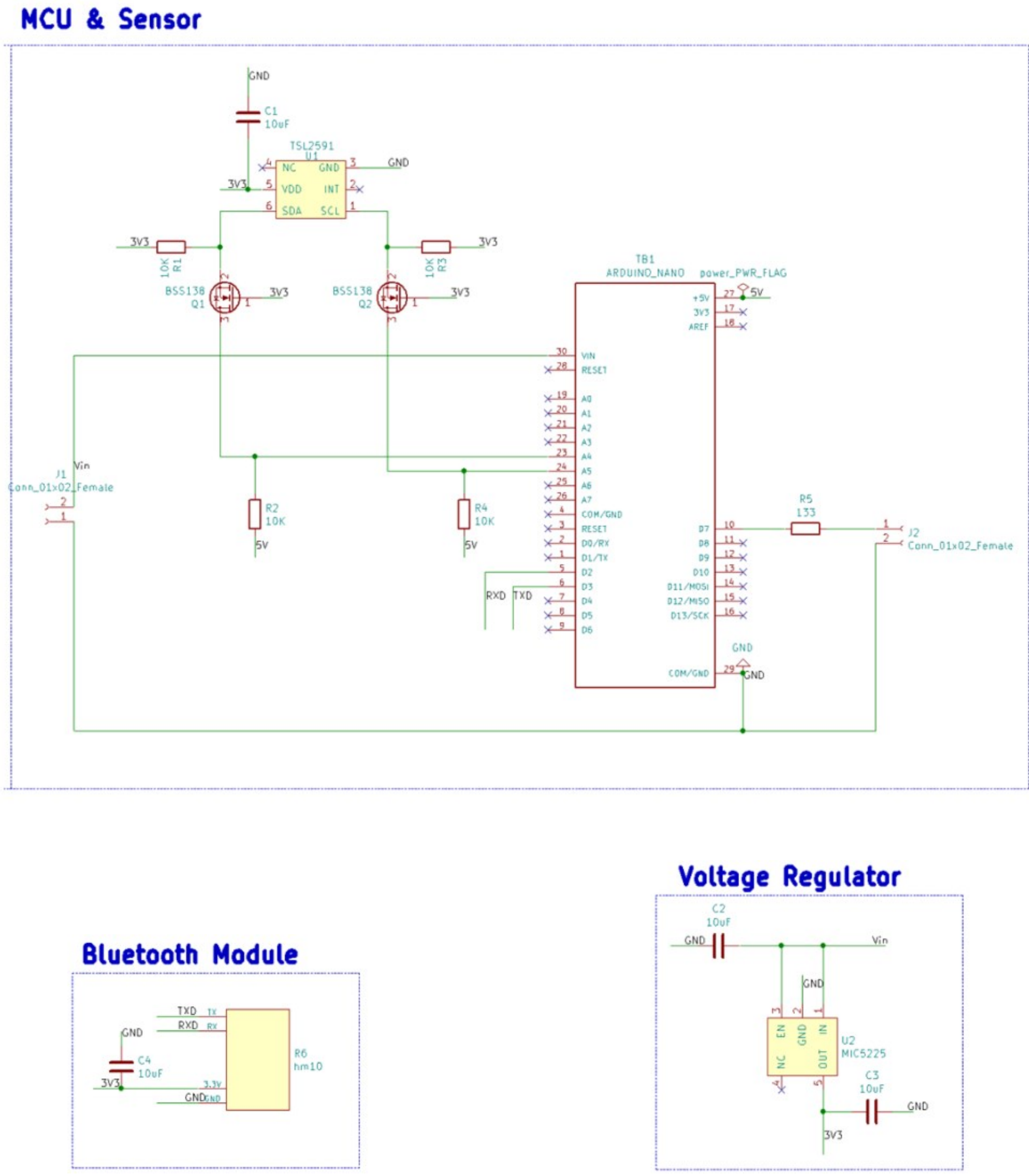


Figure S4. Miniaturized PCB design to embed a Bluetooth module, a power module, a MCU, and a sensor.

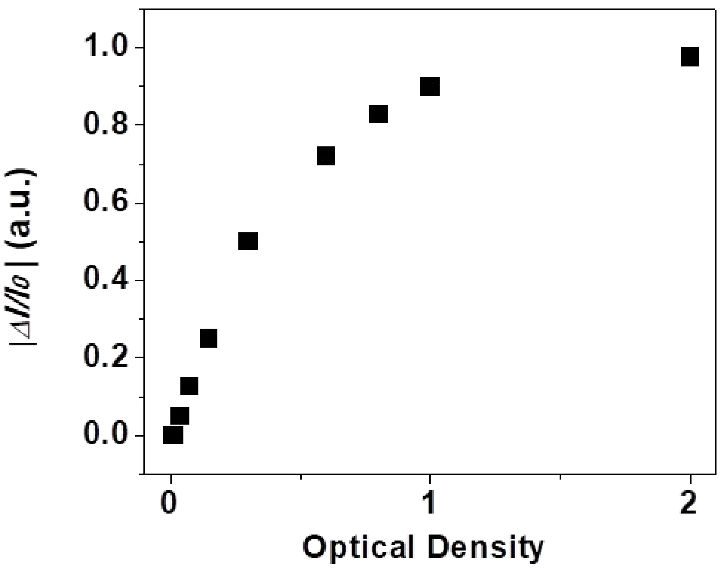


Figure S5. Photocurrent change in the underneath CMOS detector as a function of optical density (OD) from 0 to 2 in the biochip.

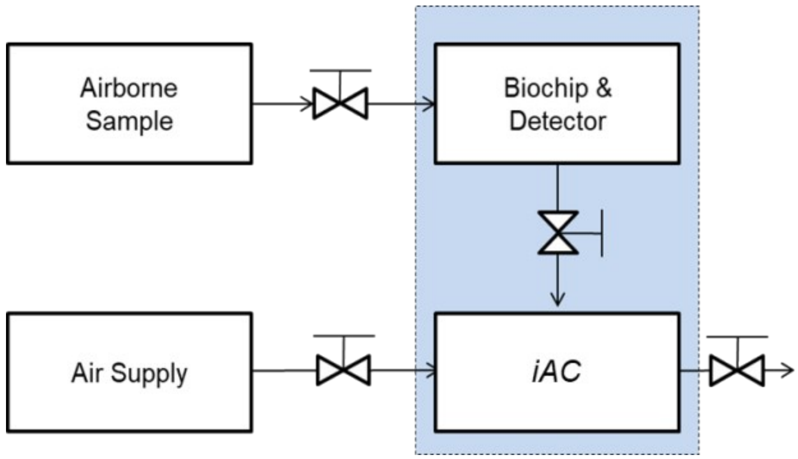


Figure S6. Operation of the integrated airborne microparticle detection-process.

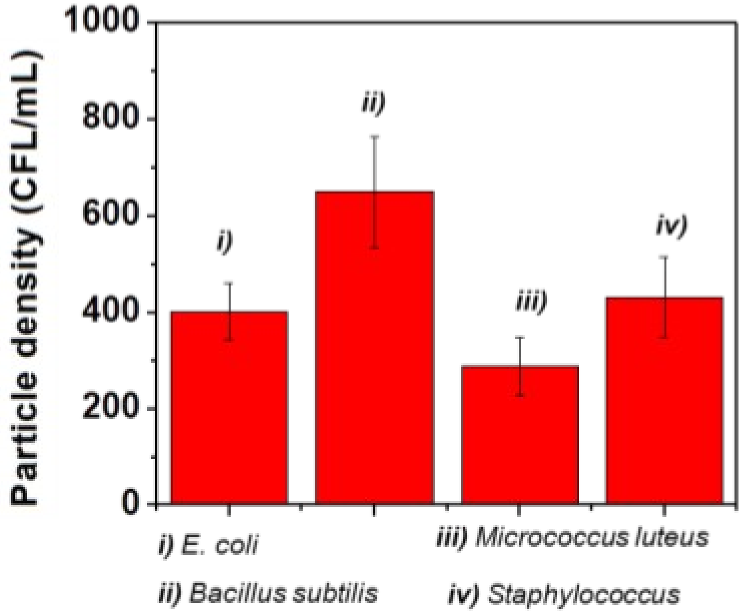


Figure S7. Comparison of LODs in the cases of *E. coli*, *Bacillus subtilis*, *Micrococcus luteus*, and *Staphylococcus* in the integrated system of the airborne microparticle collector (P_{air} = 0.06 MPa) and detector with a biochip (L = 1 cm and d = 0.5 cm) at Re = 50.

References

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2. Choi J, Kang M, Jung JH. Scientific Reports 2015;5:15983.
3. Fronczek CF, Yoon JY. Journal of laboratory automation 2015;20:390-410.
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