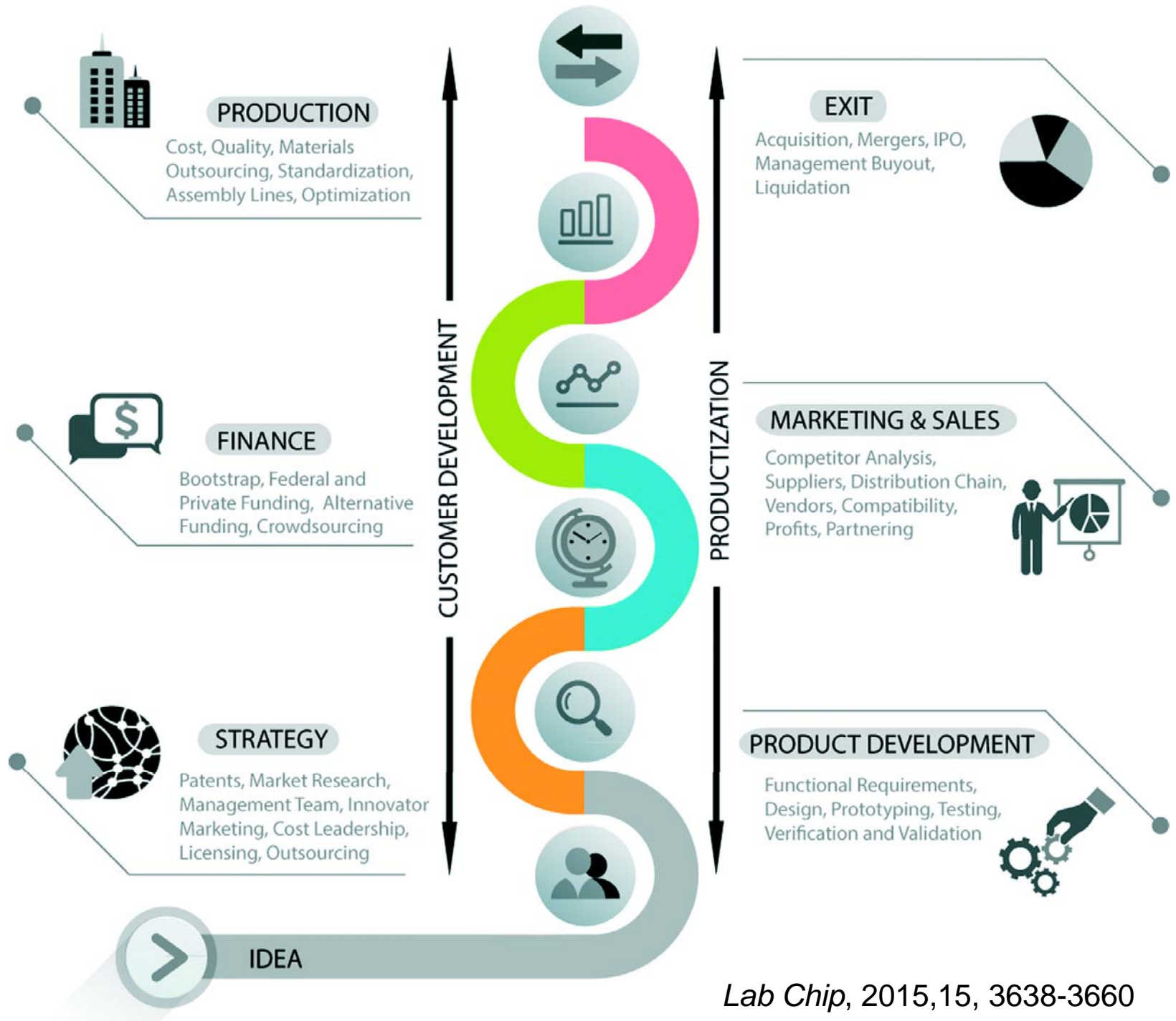


Starting Up with the Nanosensor

Mei He, Ph. D.

Assistant Professor, Biological Engineering
Kansas State University

Commercialization Roadmap



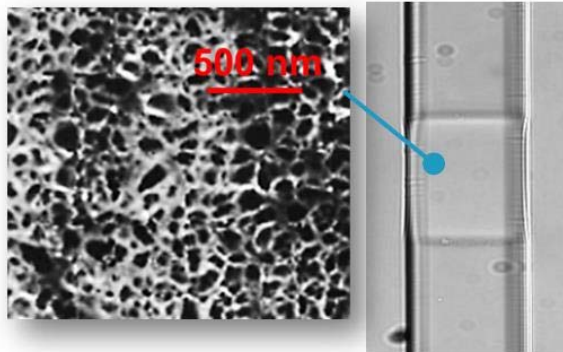
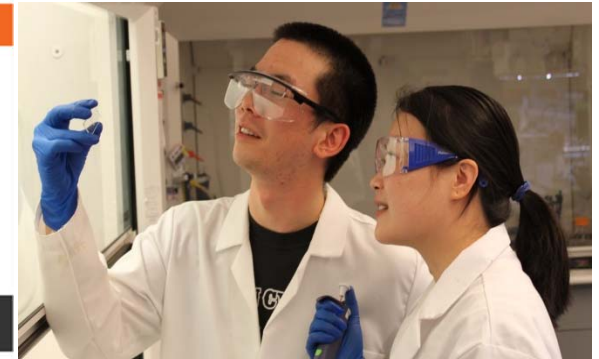
Discover & Translate Technology into Market

Lessons Learned: One size doesn't fit all

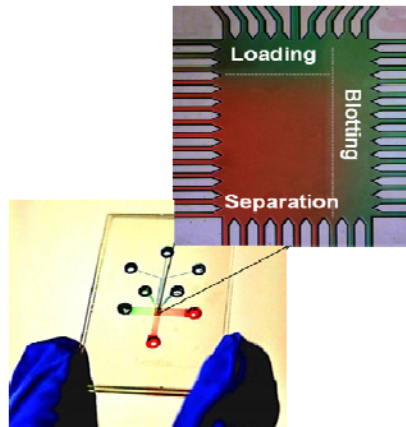
UC Berkeley



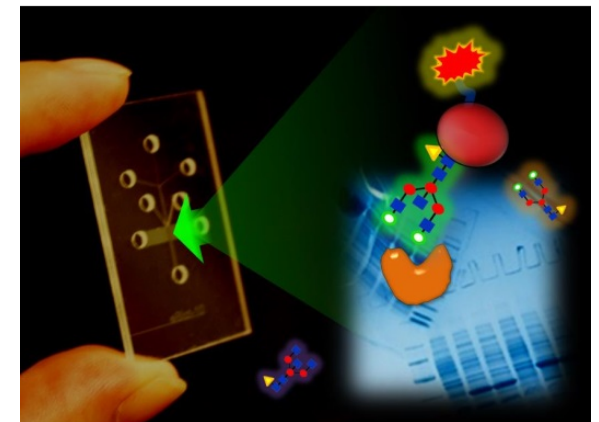
about benefits timeline **teams** partners people apply



PATENT 13/055,679



PATENT 61/560,167



PATENT 13/630, 240



Licensed by BioRad

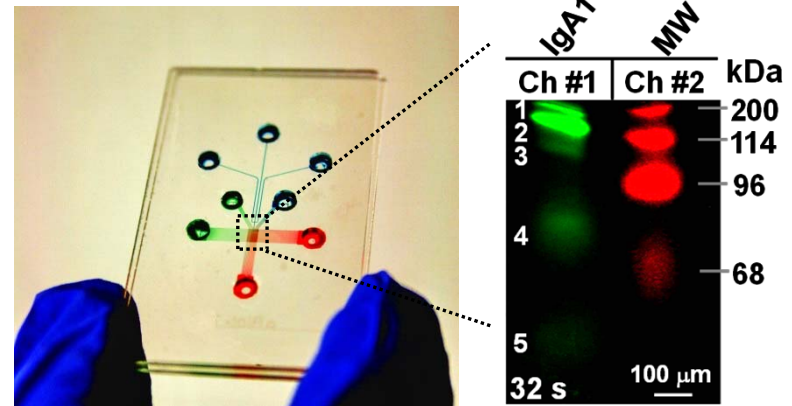
Discover & Translate Technology into Market

Lessons Learned: One size doesn't fit all

Why Western Blotting?



Automated Western Blotting enabled by nanomaterials



	On-chip	Conventional WB ¹
Efficiency	90%	67.8% ⁴
Duration	2 min	12 h

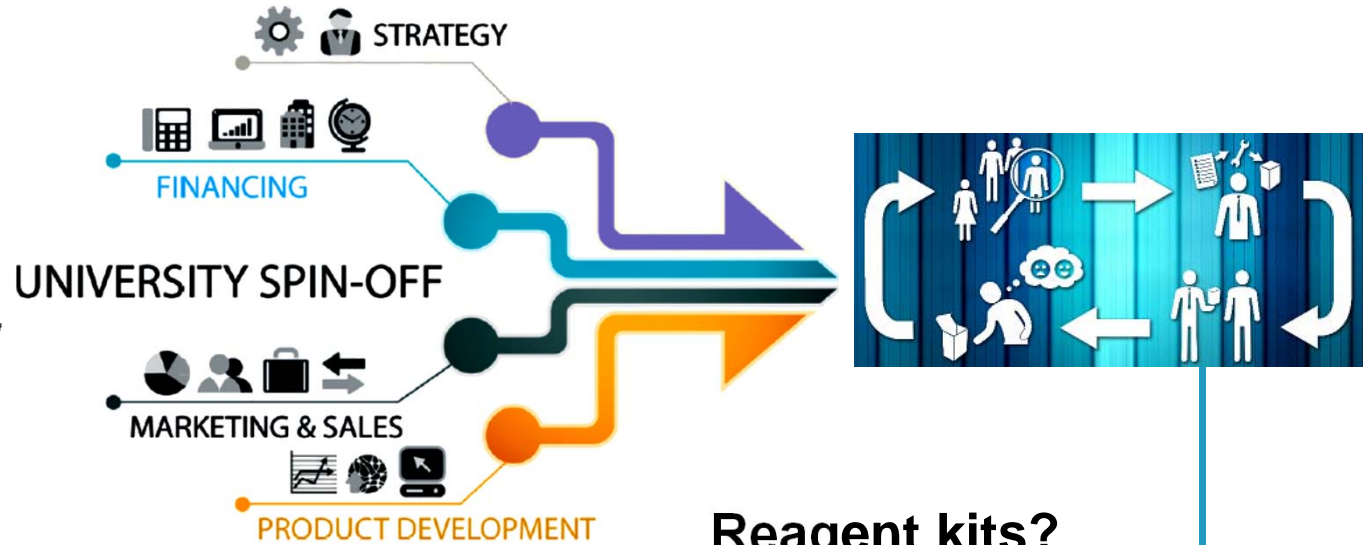
M. He *et al*, Nature Protocols, 2010, 5, 1844

M. He *et al*, Journal of the American Chemical Society, 2011, 133, 19610

Discover & Translate Technology into Market

Lessons Learned: One size doesn't fit all

Zephyrus Biosciences
Founded on 2014 by Kelly Gardner and Josh Molho



BIG news...
Milo is top innovation of 2016!



Single-cell Western Blotting



TheScientist
TOP 10
INNOVATIONS

Reagent kits?

Clinical tests?

Research tools

Acquired by ProteinSimple in 2017



How can we get here?



Laboratory Technology

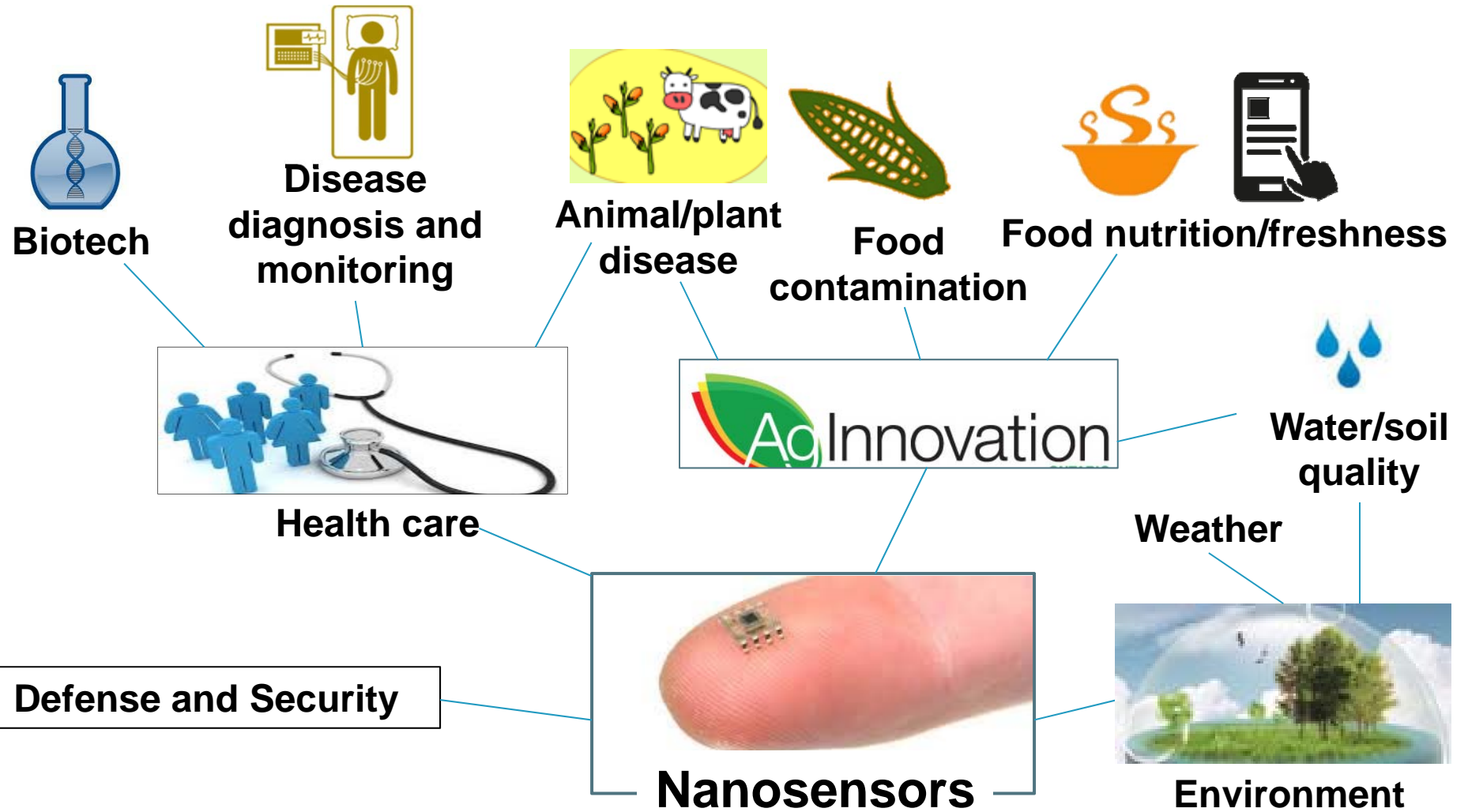


Commercial Products



What paths.....?
A better option.....?

Define the right market and usability

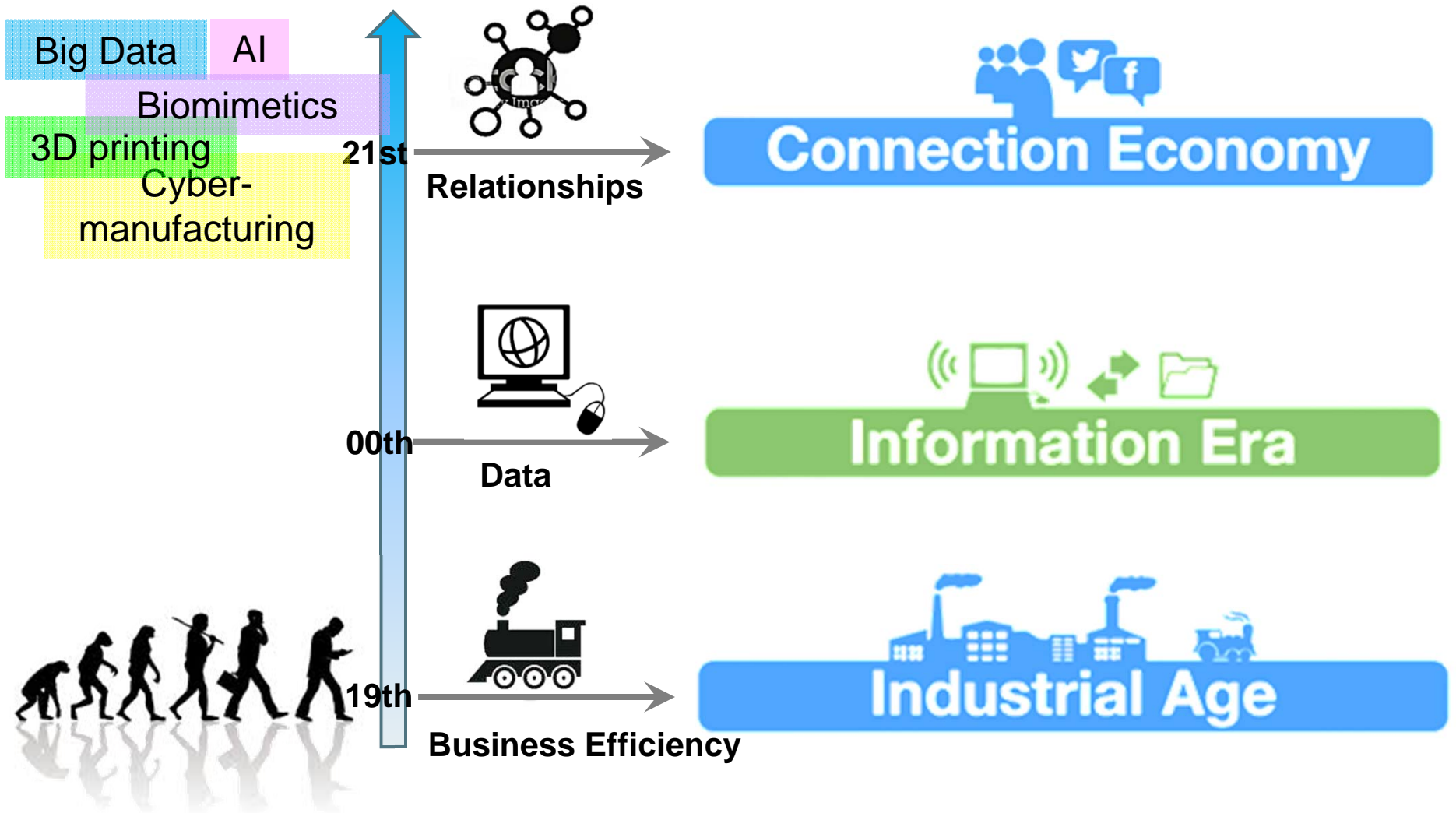


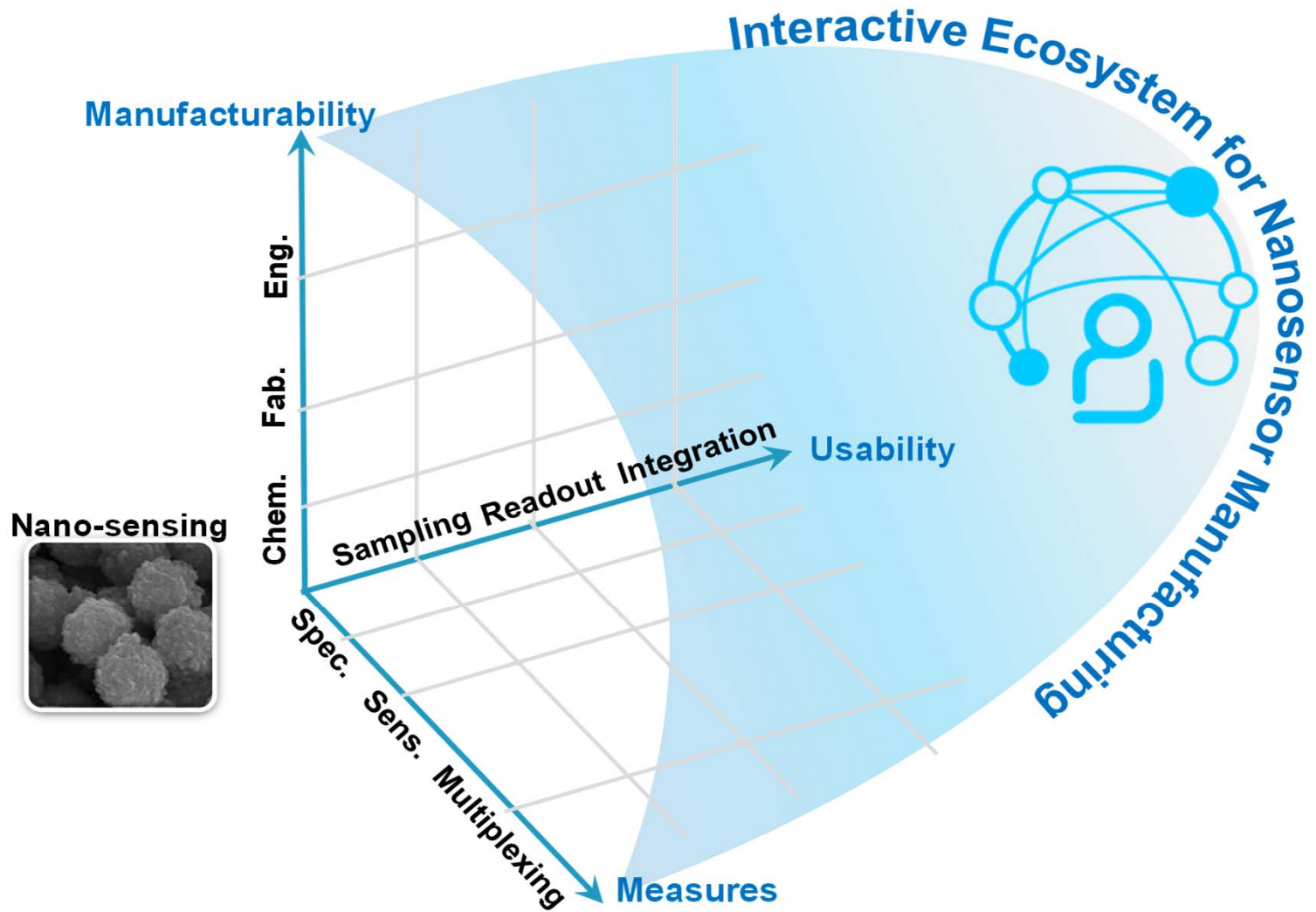
Challenges: Alterations and Alternatives



Challenges: Catch the Economic Evolution

Manufacturing/Production Evolution?



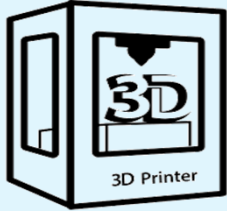


Leveraging Innovative Technologies



Additive manufacturing (3D printing):

Add another dimension of end-user engaged production



Take advantages offered by additive manufacturing for transforming nano-sensor products



If no radical alterations in products, but may improve value delivery for current products



Take advantages offered by additive manufacturing to achieve new levels of innovation in the products

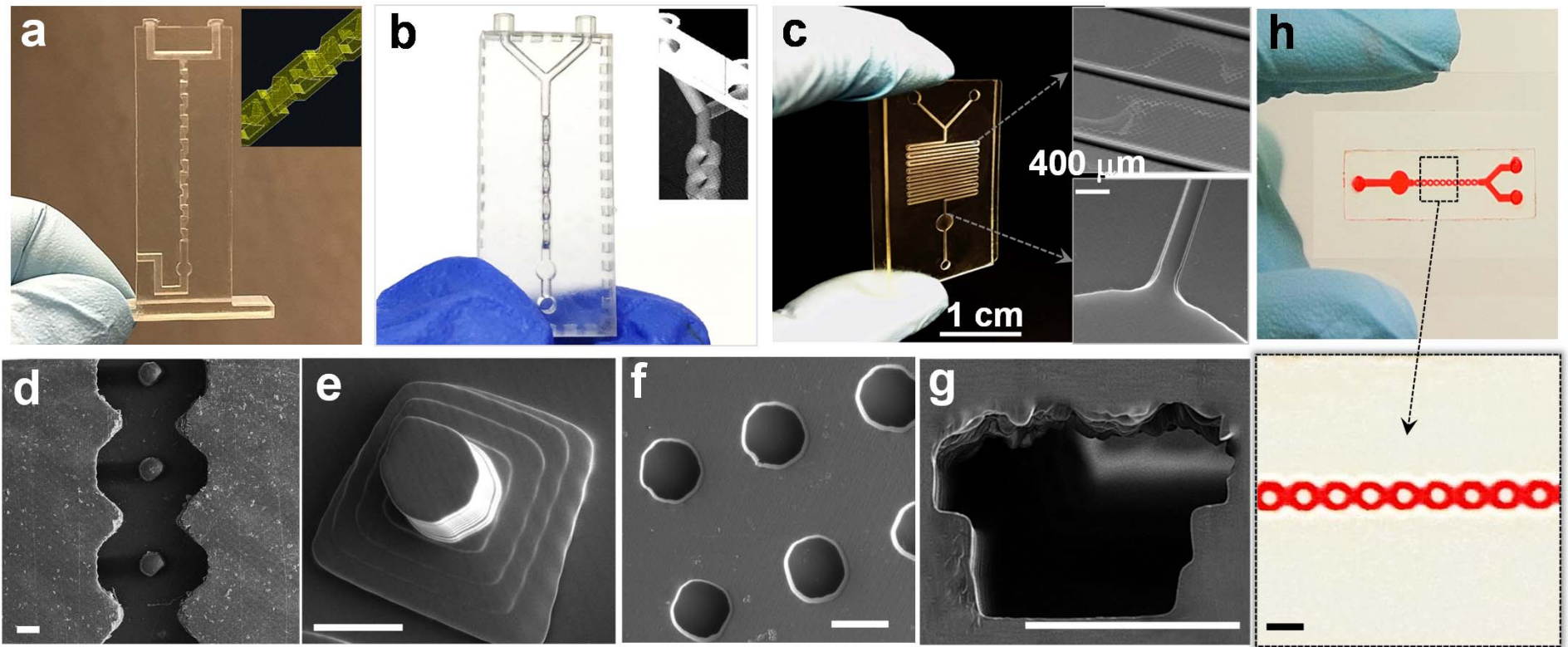


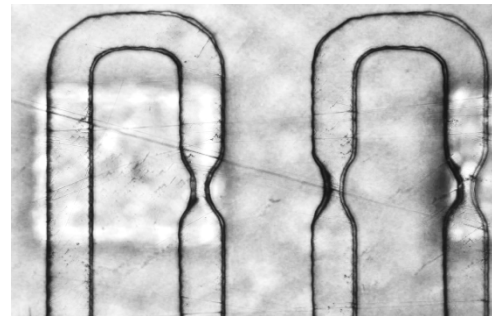
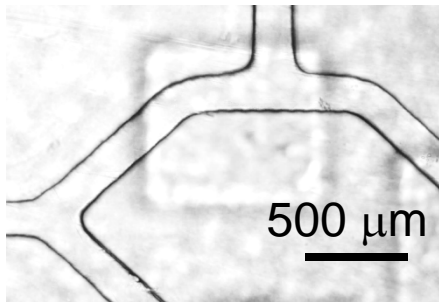
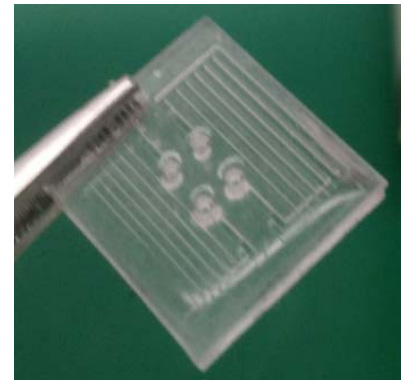
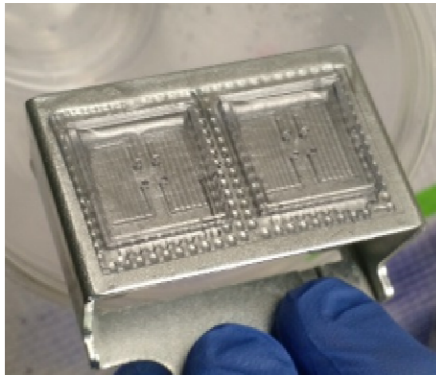
Pursue new business models for end-user engaged production

3D Printing Characterization

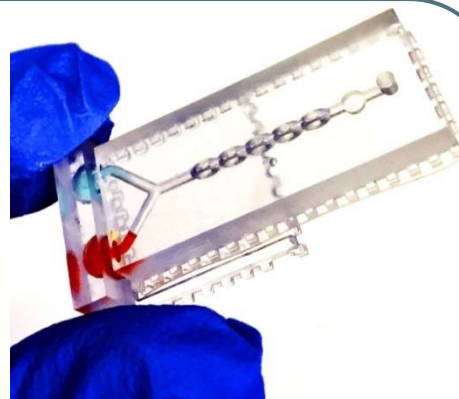
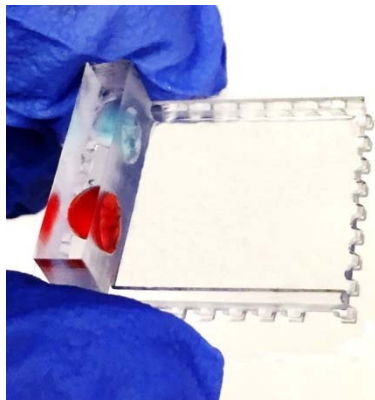
Advantages:

- One-step three-dimensional structure construction
- Simple and Fast
- No laboratory-setting needed



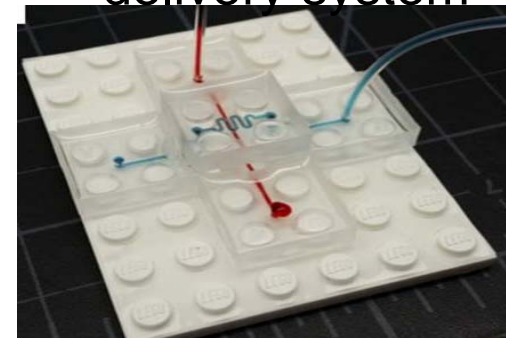


3D printed molds
for microstructure
molding



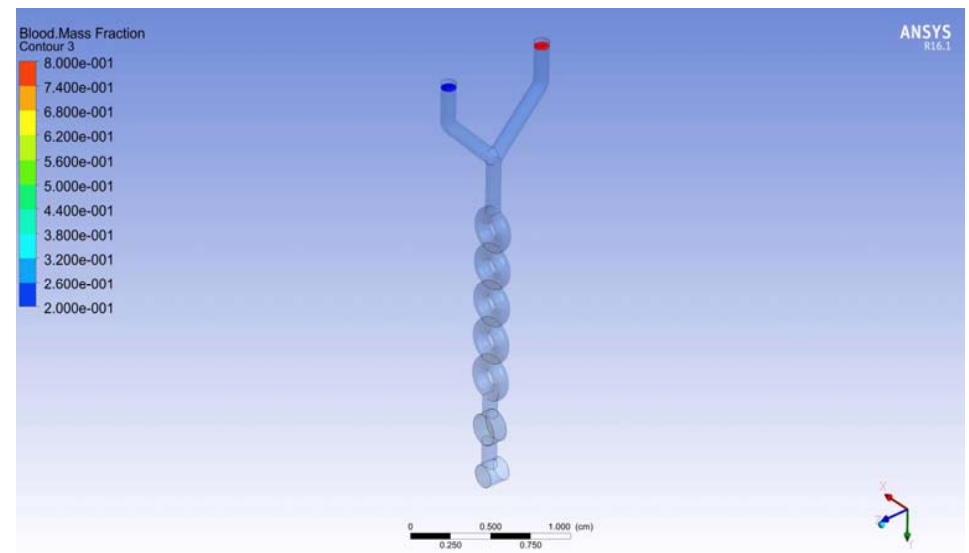
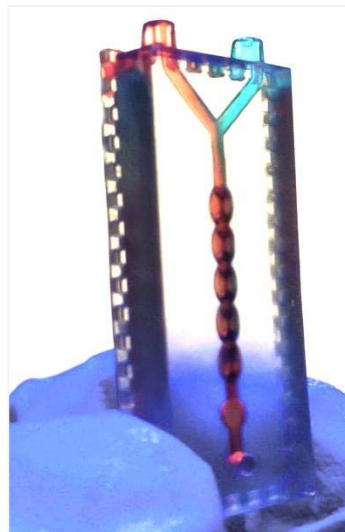
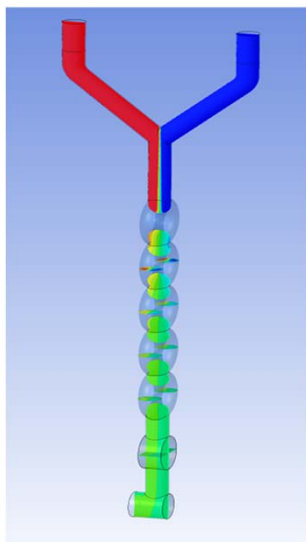
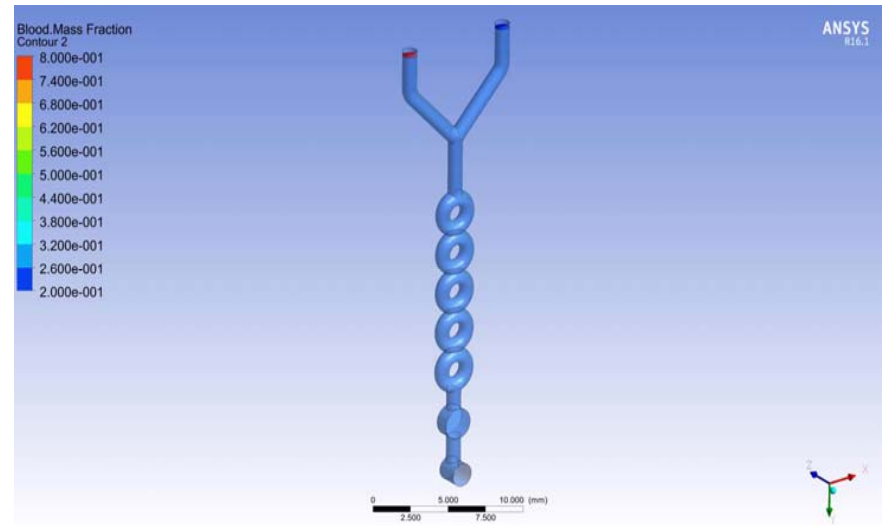
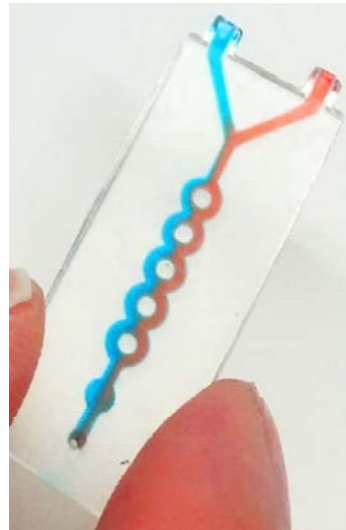
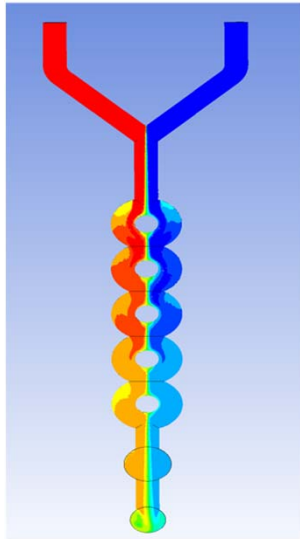
3D printed sampling well

3D printed LEGO fluidic
delivery system

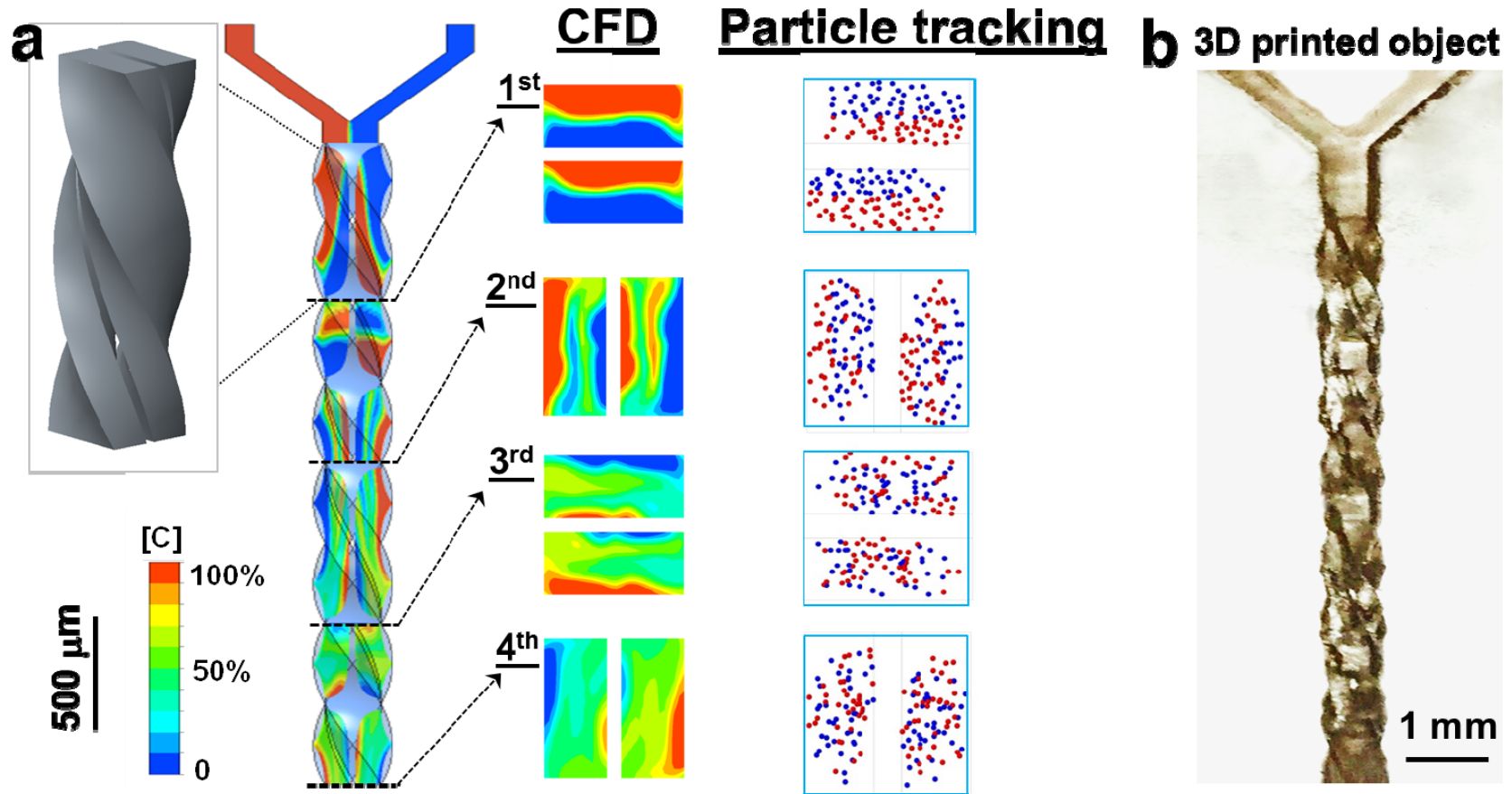


Journal of Micromechanics and
Microengineering, 2017, 27

3D Microstructures Principally Improve the Sensing Performance



3D Microstructures Principally Improve the Sensing Performance



Fast mass transfer

Improved sensing specificity and sensitivity

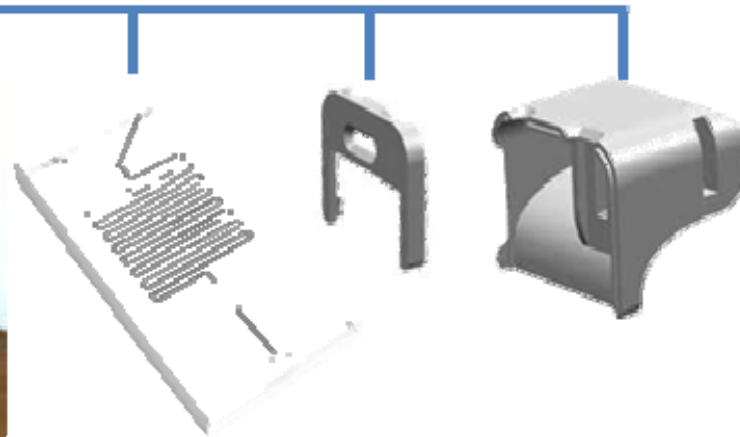
Production in the Point- of- use



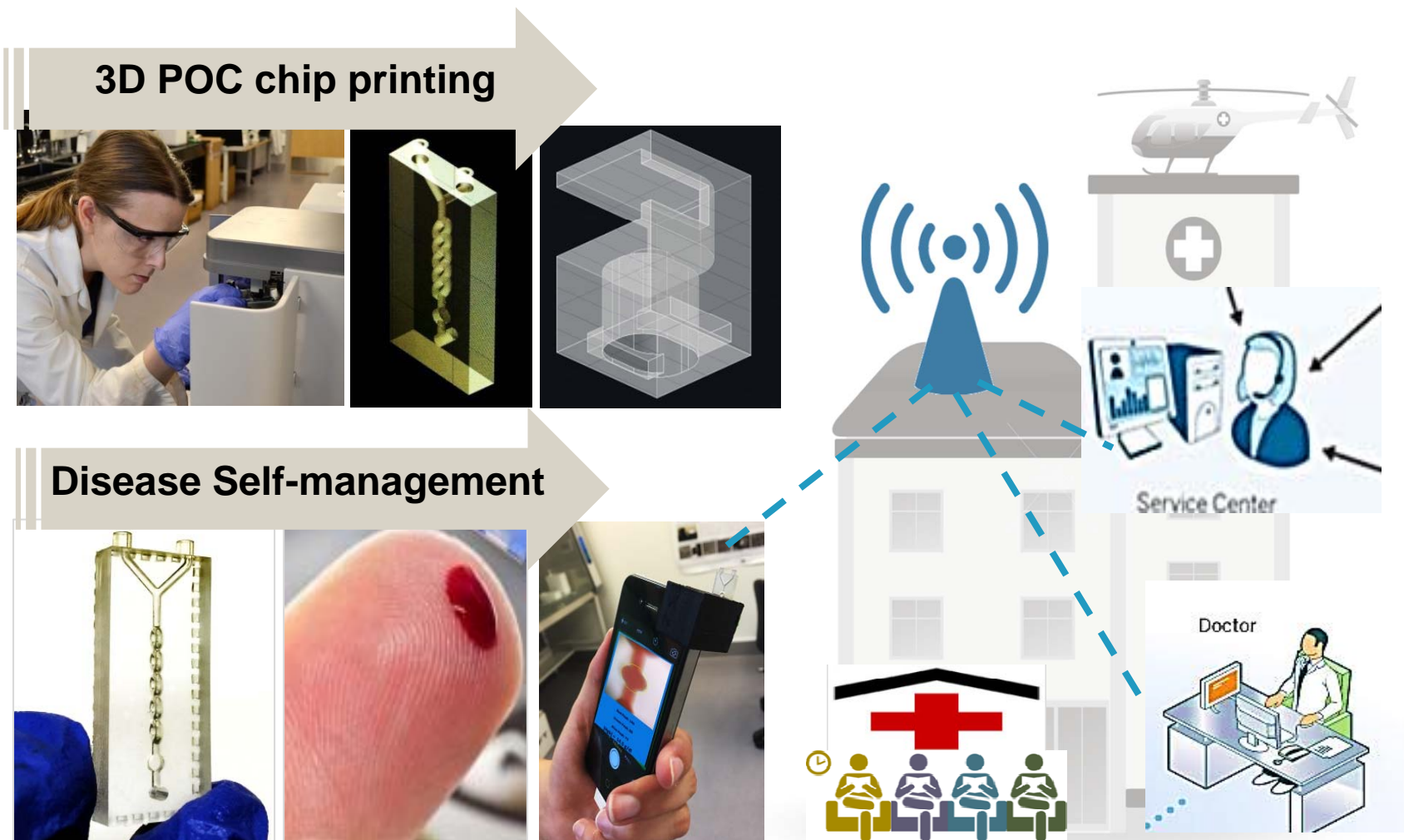
- Need laboratory settings
- Need to build infrastructure
- Very expensive
- Need professional training and skill sets

~ \$ 3,000

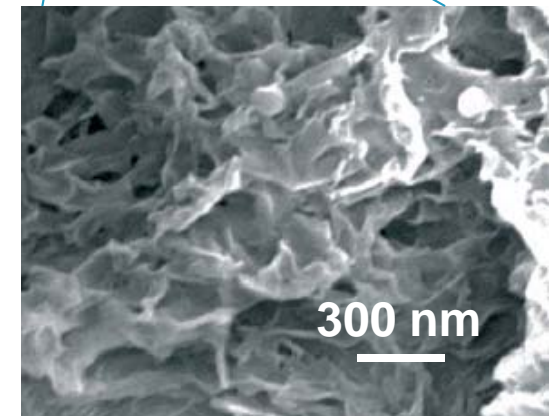
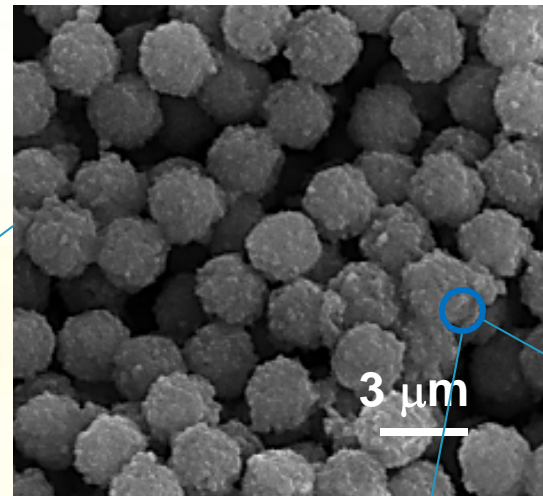
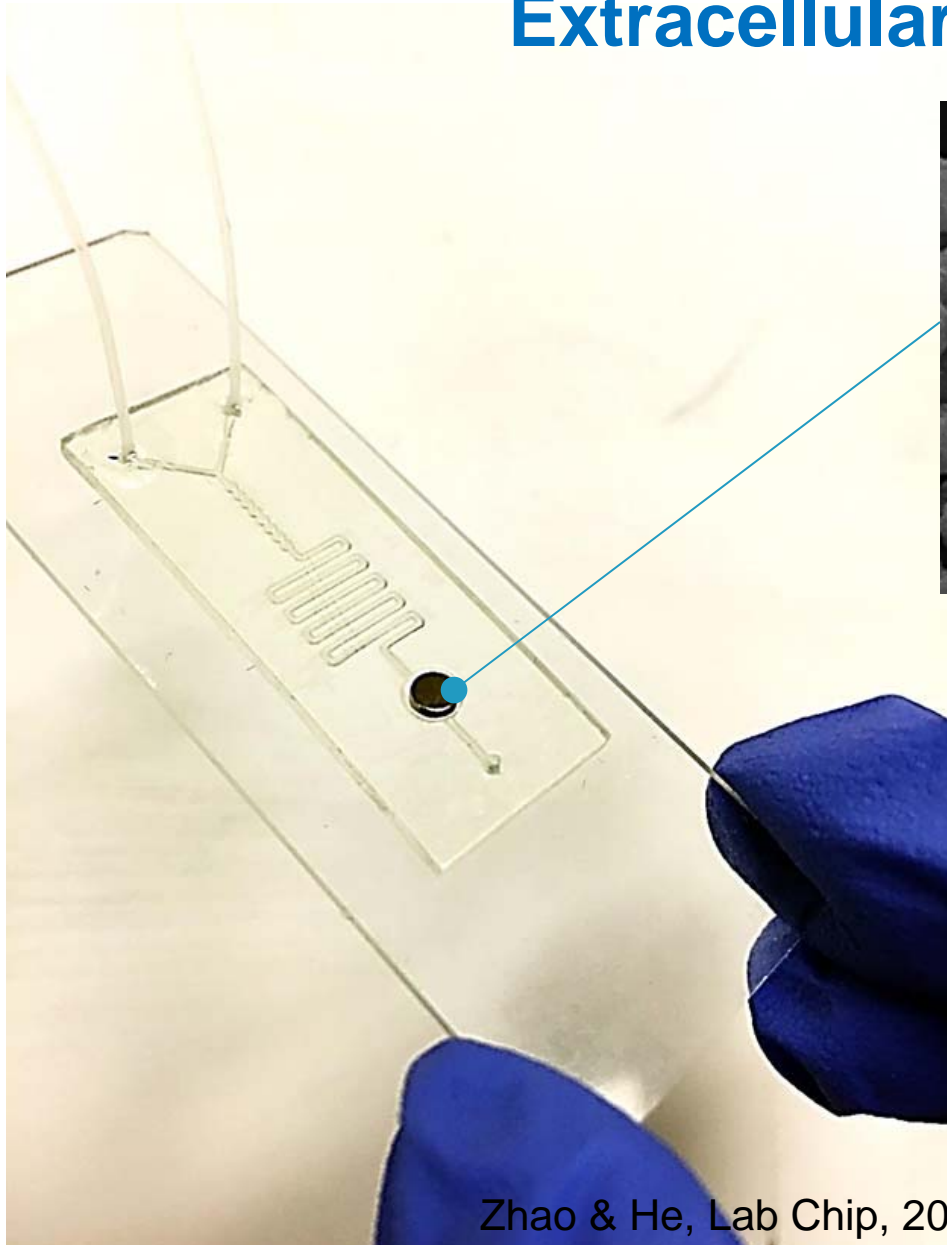
~ \$ 0.50



Capillary-force Driven Auto-mixing Enables Smartphone Diagnosis of Anemia



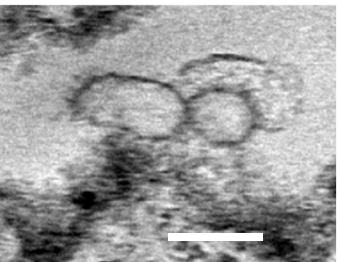
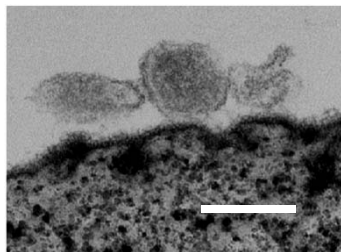
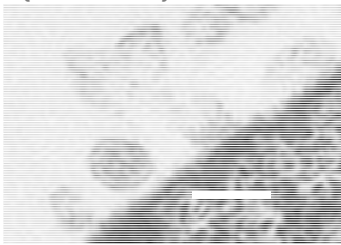
Magnetic Nanoparticles Enabled Sensing of Extracellular Nanovesicles



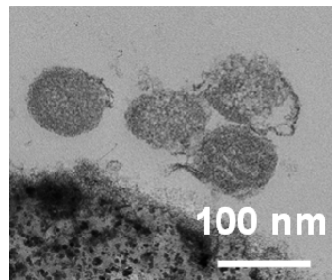
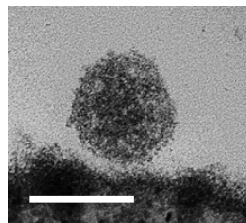
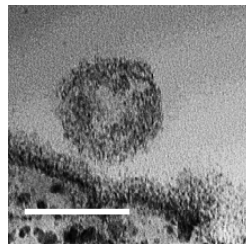
**Nano-graphene Oxide/
Polydopamine Coating**

Magnetic Nanoparticles Enabled Sensing of Extracellular Nanovesicles

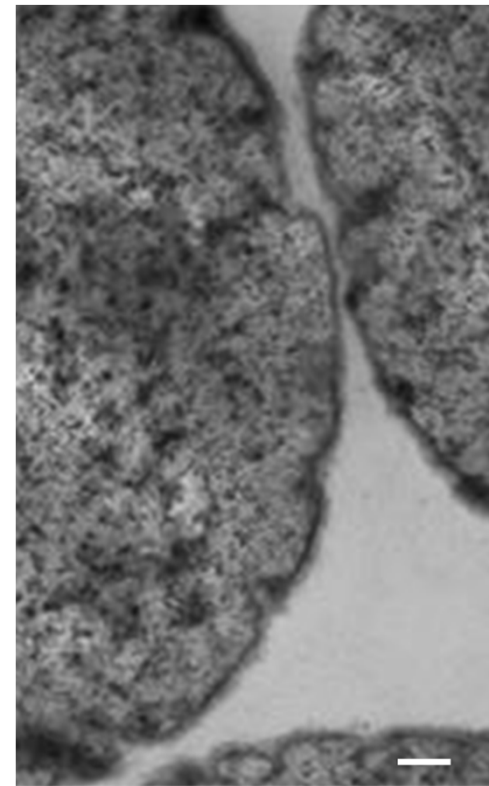
Lung Cancer
Plasma Exosomes
(CD9+)



Ovarian Cancer
Plasma Exosomes
(CD9+)

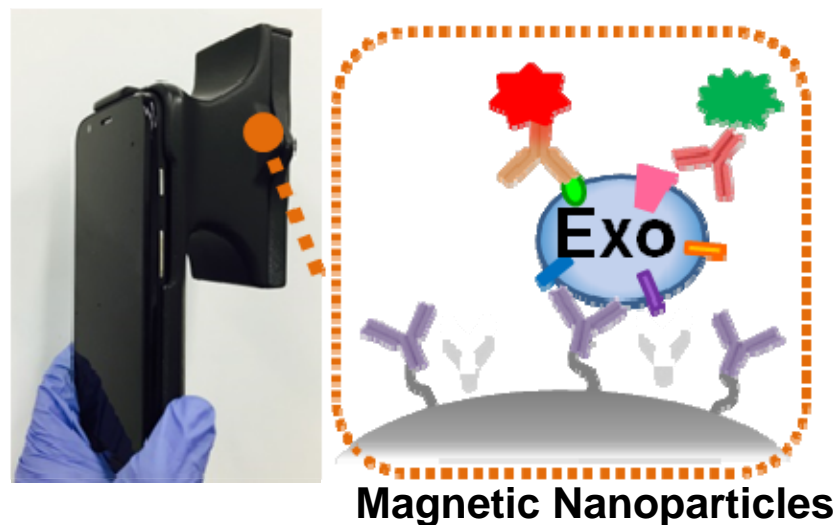
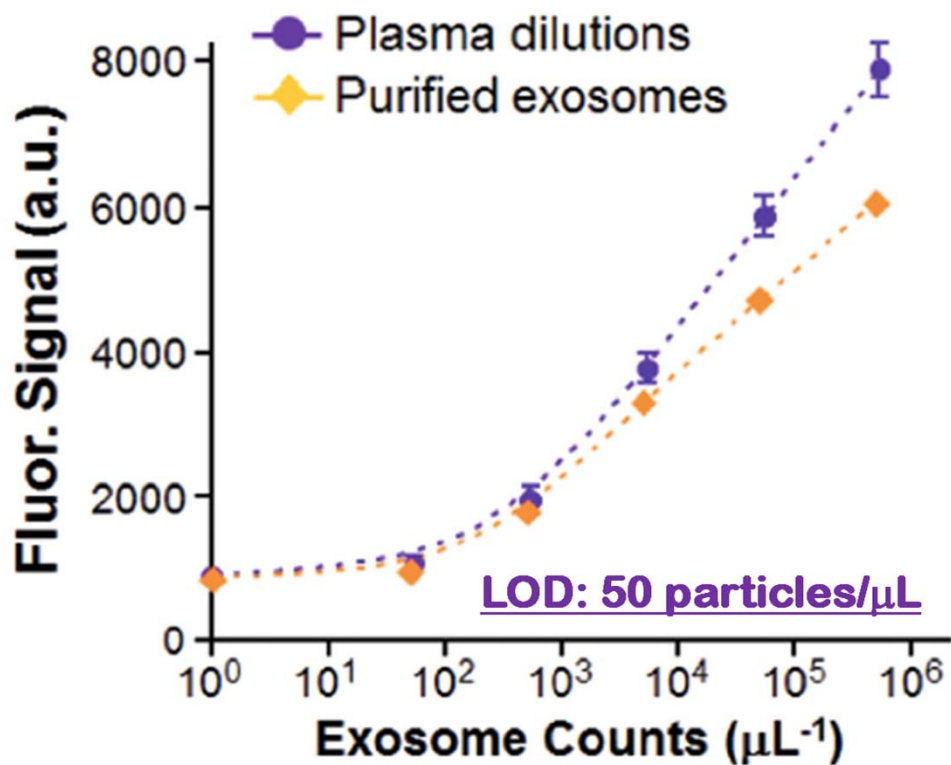


Control Beads (IgG)



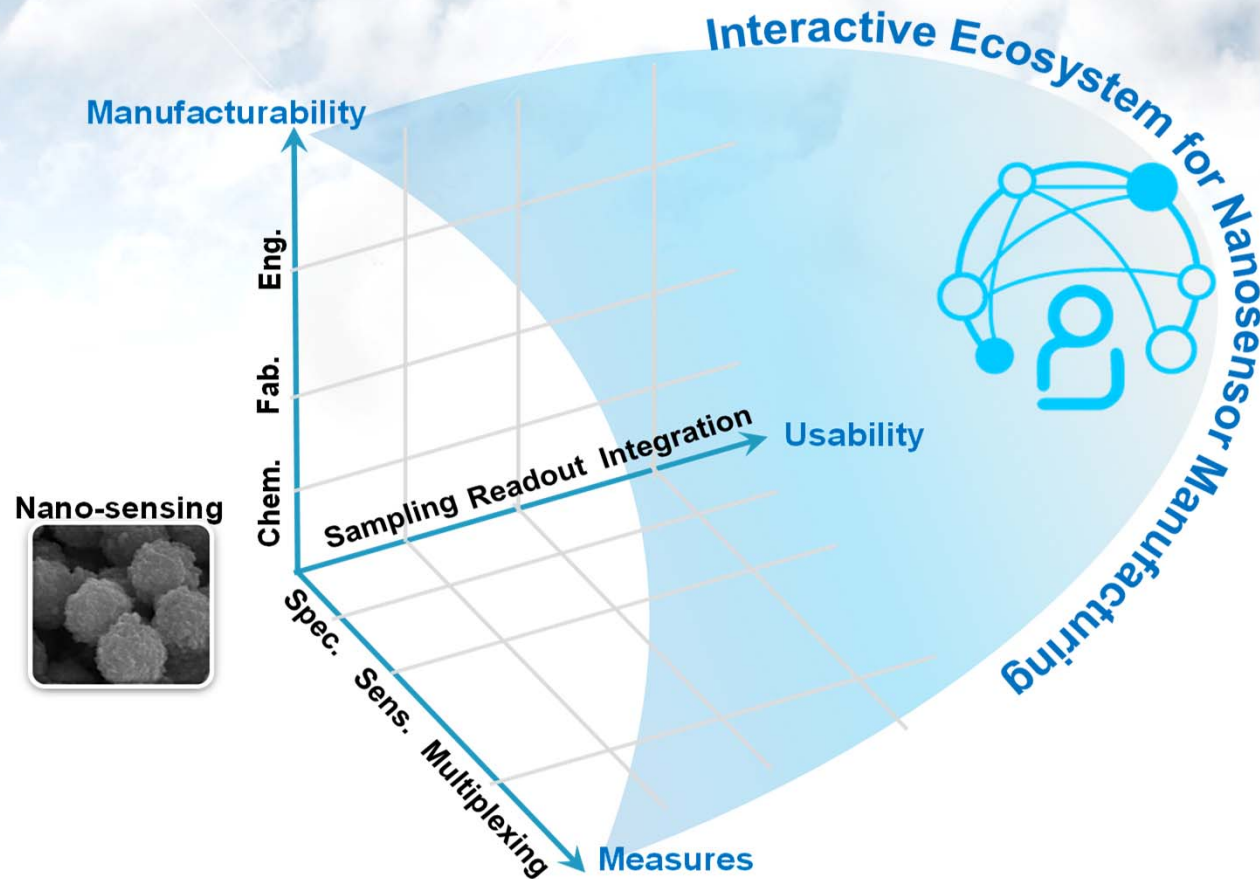
Extracellular nanovesicles, also called exosomes, are important cargoes for cell signaling, biomarker discovery, and liquid biopsy analysis

Magnetic Nanoparticles Enabled Sensing of Extracellular Nanovesicles



Conclusion, Discussion, and Future

- ❑ Leverage innovative technologies for nanosensor manufacturing
- ❑ Bridge the gap between laboratory technology and commercial production
- ❑ Establish interactive ecosystem for nanosensor manufacturing



Acknowledgement

KSU

John Sibbitt
Zheng Zhao
Dr. Philips Hochendoner
Dr. Qingfu Zhu
Kimberly Plevniak
Ethan Gotten
Brianna White
Lauren Johnson
Jianming Wen
Matthew Campbell
Dr. Steven Warren
Dr. Jodi McGill
Dr. Susan Sun

KU Cancer Center

Dr. Andrew Godwin
Dr. Chao Huang

KU

Dr. Liang Xu
Dr. Yong Zeng
Dr. Peng Zhang

UC Berkeley

Dr. Amy Herr
Dr. John Dueber
Dr. Liwei Lin

USDA/ NIFA Nanotechnology grant
NIH NIGMS P20 GM103418 Institutional Development Award
NIH NIGMS P20 GM103638 COBRE grant
KSU Johnson Cancer Research Center Foundation
Mr. Harvey McCarter Donation

