# Droplet Microfluidic Platform for High Throughput Screening and Synthetic Biology Applications

Phillip Gach [1,2], Steve C.C. Shih[1,2], Garima Goyal[1,3], Peter Kim[1,2], Manasi Raje[1,2], Joshua Heinemann[1,3], Todd Duncombe[1,2], Daniel Arlow[1,4], Kai Deng[1,2], Kosuke Iwai[1,2], Seema Singh[1,2], Kenneth Sale[1,2], , Blake Simmons[1,2], Jay Keasling[1,3,4], Paul Adams[1,3,4], Trent Northen[1,3], Nathan Hillson[1,3], **Anup K. Singh**[1,2] **(aksingh@sandia.gov)**

[1]Joint BioEnergy Institute, Emeryville, CA; [2]Sandia National Laboratories, Livermore, CA; [3]Lawrence Berkeley National Laboratory, Berkeley, CA; [4]University of California, Berkeley, CA

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**Project Goal:**
The JBEI mission is to conduct basic and applied research to enable economically-viable conversion of lignocellulosic biomass into transportation biofuels.

**Abstract:**

Microfluidic assays and devices have attracted a significant attention for performing biochemical reactions and analysis as they provide significant improvements over their macroscale counterparts with respect to speed, throughput, and multiplexing. We are involved in developing innovative microfluidic assays and integrated devices for many biofuel research applications including enzyme screening, enzyme evolution and synthetic biology. Currently, these experiments are done manually using fairly large amount of costly reagents per experiment making the process very expensive, extremely slow and irreproducible. We have developed a platform that uses droplets as discrete reaction chambers to integrate and automate the processes of reagent dispensing, addition, incubation and screening by mass spectrometry. The microscale platform allows these reactions to be performed faster using minimal manual intervention while consuming 10-100-fold lower reagents. Integration with mass spectrometry enables high sensitivity detection.

One example application is automation of synthetic biology experiments. Optimization of pathways can involve very large number of experiments as multiple variants are available for each gene. Currently, these experiments are done manually using fairly large amount of costly reagents per experiment making the process very expensive, extremely slow and irreproducible. Droplet platform can integrate and automate the processes of DNA assembly, transformation, and cell culture in one device. The hybrid chip combines droplets-in-flow and digital microfluidic (DMF) formats to take advantage of the high throughput nature of droplets-in-flow and the precise control over droplet manipulation offered by the DMF. We show that the platform is capable of accurate DNA assembly, efficient transformation, and cell culture and is compatible with many cloning methods (e.g., Golden Gate and Gibson) and chassis organisms (e.g., bacteria, yeast and fungus).

We are also integrating this platform with mass spectrometry to allow sensitive, label-free detection of chemicals and biofuels produced by the engineered cells.

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