227. High-throughput Microfluidic Platforms for Bioenergy Research

Anup K. Singh*[1,4] (aksingh@sandia.gov), Jess Sustarich[1,4], Chao Shih[1,4], Philip Gach[1,4], Joel Guenther[1,4], Randy Drevlin[2,4], Ken Sale[2,4], Nathan Hillson[3,5], Blake Simmons[2,4], Paul Adams[1,5], **Jay Keasling**[3,5]

[1]Technology Division, [2]Deconstruction Division, [3]Fuels Synthesis Division, Joint BioEnergy Institute, Emeryville, CA; [4]Sandia National Laboratory, Livermore, CA; [5]Lawrence Berkeley National Laboratory, Berkeley, CA

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Project Goals: We are developing next-generation assays for biofuels research using microfluidic technologies to provide significant improvement over conventional platforms in throughput, sensitivity, multiplexing and speed of analysis. These platforms are useful for numerous aspects of biofuels R&D including biomass deconstruction, feedstock development, and fuel synthesis.

Microfluidic platforms are finding widespread applications in biochemical analysis relevant to bioenergy research. Examples that we are exploring include screening of genetically-engineered cellulases and glycosyltransferases, assessing performance of pretreatment processes, optimization of enzyme cocktails for hydrolysis of biomass, and combinatorial screening of gene variants for optimization of metabolic pathways. For activity screening of glycosyl hydrolases and transferases, we have developed a microfluidic electrophoretic glycan analysis protocol that can be performed in a commercial microfluidic instrument. The chip allows 10-fold faster analysis than HPLC using 100-fold smaller amounts of reagents. Recently, we have been developing a droplet microfluidic platform for carrying out hundreds of reactions in parallel for two applications- a) screening of enzyme cocktails and b) combinatorial assembly of genes. Performing multi-step biochemical assays require the ability to perform functions such as droplet merging for addition of reagents and droplet sorting for selective isolation of desired reactions. We have developed innovative schemes to reproducibly merge, sort and array droplets. The droplet chip was used to screen combinations of cellulases with real insoluble substrates and the results show that the chip-based screening is an excellent agreement with conventional screening methods while offering advantages of throughput, speed and lower reagent consumption.