



Research Highlight (report date June 2011)

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Error Correction and Digitalization for Scalable Multi-Enzyme Biomolecular Computing Networks

The outcomes and their significance

Theoretical concepts and experimental realizations have been developed to allow networking without buildup of noise in multi-enzyme biocatalytic cascades processing multiple input signals analogous to digital electronics. Our recent accomplishments have included novel approaches in transforming convex response functions characteristic of biochemical reactions to sigmoidal, the latter typical in nature. These new biochemical reaction systems are versatile and can be used as signal-filtering components crucial in preventing noise buildup in networking for complex computation steps, similar to the electronic digital logic circuitry.

Biologically inspired information-processing biomolecular systems can operate as "smart" interfaces between two different universes: natural biological organisms (including humans) and man-made electronic devices. Bridging of biological objects with electronics and increasing the complexity of computational steps carried out at the biochemical level will result in novel applications for communications, sensing, implant capabilities, and medical diagnostics. Future possibility of direct integration of biological systems and electronic machines is feasible.

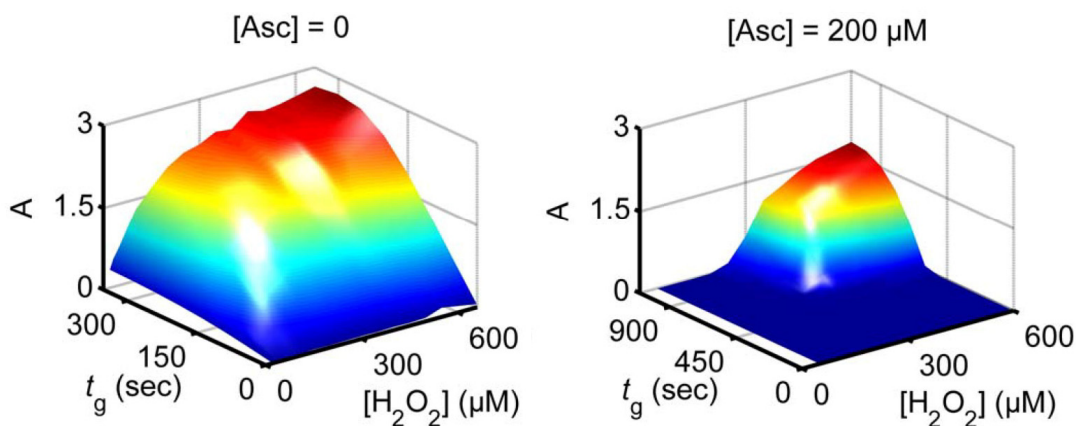
The impacts

Modern electronic devices achieve complex, scalable computation operating in a digital manner, with information being encoded in two binary-logic states, referenced as **0** and **1**. Biochemical reactions, which are natural "circuit elements" for computing with biomolecules and for biological to electronic connectivity, usually have output vs. input responses incompatible with designing of digital systems. Development of concepts and approaches to digitalization in biomolecular chemical systems allows information processing of increasing complexity and enables integrating biomolecular and electronic systems.

Our NSF-funded research has contributed to the education of students at all levels, from high school and undergraduate to graduate Ph.D. and postdoctoral, with students then continuing to industry, DOD and DOE laboratories, and academia. New coursework has been developed, and

presentations to industry have been made, including one organized and mediated by the Semiconductor Research Corporation. This naturally complements the applied dimensions of our program of biomedical and national security importance, presently supported by the Office of Naval Research.

The PIs have received numerous recognitions, including invitations for presentations and for editorial roles in scientific literature. On February 10, 2011, *Thomson Reuters* released data identifying the world's top 100 chemists, measured by the impact of their published research over the past 10 years. Dr. E. Katz was recognized as # 62 among the approximately million chemists ranked: <http://sciencewatch.com/dr/sci/misc/Top100Chemists2000-10/>, largely based on the NSF-supported work in biomolecular computing.



Measured data illustrating a theoretically designed and then experimentally implemented chemical modification of an enzyme-catalyzed biochemical reaction's response function from convex shape characteristic of standard biochemical reactions (left) to sigmoidal response (right) useful for networking for information processing.