IU BLOOMINGTON

EMERGING AREAS OF RESEARCH

Abstract Template -- Due June 30, 2017

Title of initiative to be proposed:

Rebalancing the Nitrogen Cycle

Name of lead PI, with title, department/school:

Jeremy M. Smith, Associate Professor, Department of Chemistry

Key team member names and departments/schools (up to 10 names):

Kenneth G. Caulton, Department of Chemistry
Jeffrey M. Zaleski, Department of Chemistry

Description of area to be proposed. What constitutes this area of research or creative activity as emerging? (Word limit=500)

The pollution of lakes and coastal bays by agricultural nitrogen fertilizer runoff, causing eutrophic algal growth, is a societal problem on a global scale that is superseded only by the buildup of carbon dioxide and other greenhouse gases in the atmosphere. The ability to deliver pure water (e.g. for residential use), and remediate the planet's soil and atmosphere by transformative catalytic science is recognized as an emerging area of chemical research at the most fundamental level, but one that is currently neglected by skilled observers of a dying planet. We currently lack chemically and energetically effective methods to respond to the needed recycling of agricultural nitrogen waste, which is essential for fertilizing planetary food production.

We will invent economical catalysts that use solar power to convert nitrogen-containing field runoff into value-added products, including the recycling of these pollutants back into agrochemicals. Sustainability will be built into the construction and operation of these new catalysts by building on the scientific breakthroughs in other catalyst-based environmental remediation processes, such as carbon dioxide recycling. We will pursue two strategies in catalyst design: (1) Molecular catalysts based on sustainable, inexpensive and nontoxic elements (e.g. iron) that are encased in a bioinspired, enzyme-like periphery will efficiently use energy harvested from sunlight (sourced from existing and developing photovoltaic technologies) for selective catalysis; and (2) Nanoparticle catalysts will capture solar energy, use their sharply pointed surface features to both concentrate this energy as well as create unique reactive sites for agricultural nitrogen waste conversion.

The long term goal of our research is the development of new technologies for nitrogen waste conversion that can be "deployed and forgotten," including in developing countries that have minimal infrastructure but abundant solar energy flux. By solving societal environmental problems, we will impact quality of life on a worldwide scale, deliver pure water and diminish the current cost of environmental remediation. The global impact of this emerging area forms a platform for innovative hiring and attracting long-term funding from the federal government and agrochemical companies, and will make Indiana the pioneering center for research towards a goal which is currently neglected around the world.

Please submit to earprogram@indiana.edu