SD NASA EPSCoR 2011 Major Research Grants
(Approved for funding Sept. 1, 2011 - Aug. 31, 2014)

South Dakota investigator(s) and affiliation	Project title	NASA funds	NASA and other collaborations
PI: Edward Duke, SDSM&T Co-I/Science PI: Dr. David Salem, SDSM&T Co-I: William Cross, SDSMT; Marc Robinson, SDSMT; Ranjit Koodali, USD; Zhenqiang Wang, USD	Structural Thermal Insulation Composites	$750,000	Luke Roberson, Materials Scientist, NASA Kennedy Space Center; Bjorn Forsdal, COO ReforceTech; Vladimir Brik, Head of Fiber Technology , ReforceTech; Kumar Natesaiyer, Director of Developing Technologies and Open Innovation, USG Corporation; Steven Smith, Nanoscience and Nanoengineering Program, SDSMT; Charles Jason Tinant, Co-Chair Math and Science Dept., Oglala Lakota College; Damon Fick and Marion Hansen, Civil and Environmental Engineering Dept., SDSMT
PI: Edward Duke, SDSM&T Co-I/Science PI: Dr. William Gibbons, SDSU	Cyanofactory Platform to Photosynthetically Produce Advanced Fuels and Chemicals, While Providing Bioregenerative Life Support Services	$750,000	Jonathan Trent, Senior Scientist, NASA Ames Research Center; Ruanbao Zhou, Biology and Microbiology Department, SDSU; Kasi Muthukumarappan, Gary Anderson, Zhengrong Gu, Agriculture and Biosystems Engineering Department, SDSU; XingZhong Yan, Electrical Engineering and Computer Science Department, SDSU; Robb Winter, David Salem, Department of Chemical and Biological Engineering, SDSMT; Deig Sandoval, Math, Science and Technology Department, Oglala Lakota College; Gary Kolbasuk, Product Development Manager, Raven Industries; Douglas Rivers, Director Research and Development, ICM, Inc; Mark Luecke, CEO, South Dakota Innovation Partners, LLC.

Project Summaries
(Funded South Dakota NASA EPSCoR 2011 Major Research Projects)

Structural Thermal Insulation Composites

The primary goal of the proposed research is to develop a multi-functional structural composite insulation system for lunar habitats which is optimized to minimize thermal conductivity and maximize mechanical (strength) properties. This project will directly address NASA's ESMD mission to develop a sustained human presence on the moon and to promote exploration and commerce.

To achieve this goal a research team composed of faculty and graduate student members from the South Dakota School of Mines and Technology (SDSM&T) and the University of South Dakota (USD) as well as NASA and industry partners will be assembled. The goals and objectives of this research will be addressed by (1) developing and evaluating the performance of constituent insulating nanomaterials, and

(2) fabricating and testing strong, load-bearing, high-thermal-insulation composite panels assembled from selected constituent materials.

This proposal describes an integrated plan to (1) develop thermally insulating structural composites, (2) establish a multi-institutional research team in South Dakota focused on advanced multifunctional materials and develop a thermal management laboratory, (3) strengthen collaborations with scientists at NASA Kennedy Space Center to develop and evaluate innovative nanomaterials based on hollow fiber technology and state-of-the-art thermal management, (4) enhance multi-level education on structural composite materials and thermal measurement devices for undergraduate and graduate students, including Native American students, and (5) collaborate with industrial partners to promote economic development activities.

This project will be carried out through collaboration of faculty members (from two research universities and one tribal college in South Dakota), NASA research scientists, graduate and undergraduate students, and industrial partners. It will be monitored for both research and education activities. The successful outcomes of this project include the establishment of a multi-institutional research cluster, the development of advanced structural insulating composites, the education of students, and the promotion of economic development activities.

Cyanofactory Platform to Photosynthetically Produce Advanced Fuels and Chemicals, While Providing Bioregenerative Life Support Services

This project will bring together a multi-institutional, multi-disciplinary research team from South Dakota State University, South Dakota School of Mines and Technology, and Oglala Lakota College to (1) create highly productive and industrially robust strains of cyanobacteria to produce energy dense fuels, high value chemicals, O2, and cleansed water directly from CO2, sunlight, and wastewater, (2) develop an integrated photobioreactor (PBR) and product recovery system, driven by solar power provided by light fibers, (3) strengthen collaborations with the NASA Ames Research Center (ARC) to also improve performance of the Offshore Membrane Enclosures for Growing Algae (OMEGA) system, (4) enhance multi-disciplinary undergraduate and graduate education on molecular engineering, bioprocessing systems, and applied photonics, including Native American students, and (5) collaborate with industrial partners to promote economic development in South Dakota. Our initial target product is linalool, a ten-carbon alcohol with an energy density of 40 MJ/kg, heat of vaporization of 0.19 MJ/kg, and octane of 102. This Cyanofactory platform could be easily reengineered to produce other fuels/chemicals. This project will provide "Game Changing" technology to the Office of the Chief Technologist (OCT), and will help resolve critical issues in both the "Space Power and Energy Storage" and the "Human Health, Life Support and Habitation Systems" roadmaps. This proposal also addresses two of NASA's grand challenges (Space Colonization and Affordable Abundant Power). The Exploration Systems Mission (ESMD) and Space Operations Mission Directorates (SOMD) will benefit by development of an integrated system that can support colonization missions by (1) producing chemical building blocks and fuels from sunlight, wastes, and CO2, and (2) producing O2 and cleansing water to maintain life support. This project will help the Aeronautics Research Mission Directorate (ARMD) address the goal of providing renewable, energy dense biofuels in a sustainable manner, while sequestering CO2. Our efforts will create a new relationship with NASA, build infrastructure and expertise in a novel Cyanofactory platform, make South Dakota researchers more competitive for follow-on funding, and create economic development opportunities.

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