Core Research Activity:	Experimental Program to Stimulate Competitive Research
Division:	Materials Sciences and Engineering
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Portfolio Description:

Basic research spanning the entire range of programmatic activities supported by the Office of Science in states that have historically received relatively less Federal research funding. The DOE designated EPSCoR states are Alabama, Alaska, Arkansas, Delaware, Hawaii, Idaho, Kansas, Kentucky, Louisiana, Maine, Mississippi, Montana, Nebraska, Nevada, New Mexico, North Dakota, Oklahoma, South Carolina, South Dakota, Tennessee, Vermont, West Virginia, and Wyoming, and the Commonwealth of Puerto Rico and US Virgin Islands. BES manages EPSCoR for the Department.

Unique Aspects:

The program objective is accomplished by sponsoring two types of grants: 1) Implementation Grants, and 2) Laboratory-State partnership Grants. Implementation grants are for a maximum period of six years with an initial grant period of three years. Maximum funding for these grants is $750,000 per year. One-to-one state matching funds are required. The Laboratory-State partnership grants are for a period of one to three years. Maximum funding for these grants is $150,000 per year. Exactly 10% state matching funds are required. DOE/EPSCoR has placed a high priority on integrating the scientific manpower development component with the research component of the program. In addition, it is promoting strong research collaboration and training of students at the DOE national laboratories where unique and world-class facilities are supported by the Department. This program is science-driven and supports the most meritorious proposals based on peer and merit review. Workshops and discussions are regularly held with representative scientists from EPSCoR states to acquaint them with the facilities and personnel at the DOE laboratories.

Relationship to Others:

The core activity interfaces with all other program core activities within the Office of Basic Energy Sciences. In addition, it is responsive to programmatic needs of other program offices within the department.

Significant Accomplishments:

The EPSCoR program funds basic research in support of all programmatic needs of the department. The accomplishments are grouped according to the relevant DOE programmatic office.

- **Basic Energy Sciences**: 1)Researchers at the university of Alabama have experimentally established the remarkable tolerance of ilmenite-hematite (IH) materials to neutron and proton radiations. The IH of all compositions retain their semiconducting and magnetic properties even after being exposed to these radiations for an extend time. A simple two terminal “varistor” devices using both ceramic and film structures was constructed and demonstrated that they retain their characteristics almost unaltered after irradiation. This can lead to development of IH based devices suited for applications in space and in radiation environments. 2) Micro-optics group in Montana has developed and demonstrated fast focus control using a deformable mirror. This deformable mirror can change its shape in response to a control voltage, thus changing the focus in an optical instrument. Because the mirror is small this shape change can happen in a few microseconds. Optical Coherence Tomography (OCT), uses backscattered light from a laser beam to image tissues in the body. Focus control for an OCT system requires the ability to change focus cyclically at the line scan rate, typically 8 to 16 kHz, faster than is possible using traditional mechanical focus adjustment. This focus control is easily accomplished with the newly developed mirrors, and will enable much higher resolution OCT imaging in the future.
- **Biological and Environmental Research**: Abasic sites are the most common DNA damages and are replication-blocking lethal and mutagenic lesions. Scientists working on this project have successfully crystallized for the first time a replicative DNA polymerase in complex with DNA that has just incorporated a nucleotide opposite an abasic site. This structure is unique in that multiple protein conformations have been captured within a single crystal that represent steps along the switching pathway between the DNA polymerizing and editing modes of the protein. The results show that when a nucleotide is incorporated opposite

an abasic site, the DNA geometry becomes distorted, the DNA fails to translocate and switches to the editing mode, thus accounting for the ability of an abasic site to block replication

- **High Energy Physics**: The unification of forces in four space-time dimensions helps us to understand the three apparently different gauge interactions, strong, weak and electromagnetic, in terms of a single gauge interaction. Such a grand unification has been tested experimentally and works very well. However, there are Yukawa interactions, responsible for giving masses to all fermions, which are completely unrelated to the gauge interactions. In the context of higher dimensions, the Higgs fields can be extra dimensional components of the gauge fields, and the Yukawa interactions are just part of the gauge interactions in higher dimensions. The gauge symmetry is broken by compactifying the extra dimensions on an orbifold. In this project a theory is proposed which achieves such a true unification. The theory is based on two extra space-like dimensions with super symmetry. This theory gives rise to unification of the gauge and Yukawa couplings, in remarkable agreement with the current data. The theory also makes predictions which can be tested in the upcoming Large Hadron Collider. This work has achieved for the first time, the true unification of all the elementary particle and forces in the framework of local quantum field theory.

- **Renewable Energy and Efficiency**: The researchers at Jackson State University are working to improve the amount of ethanol that can be produced from Southern Pines. Acid hydrolysis is being developed for conversion of biomass into a liquid process stream (hydrolyzate) that can be either directly fermented into ethanol or further processed by enzymatic conversion into a then more fermentable stream used to make ethanol. Southern Pine acid hydrolyzate containing sugars and inhibitors, such as furans and phenolics, was treated with a weak anion resin and laccase immobilized on kaolinite. Fermentation of the sugars in the treated hydrolyzate resulted in significantly higher ethanol production levels than those achieved with the untreated hydrolyzate.

- **Defense Programs**: Optical sensors based on Faraday rotation were developed for monitoring electric and magnetic fields. These sensors are being developed for use in improved operation of the electron beam accelerators and imaging systems that are used in DOE stockpile stewardship program.

Mission Relevance:

The principal objective of the DOE/EPSCoR program is to enhance the abilities of the designated states to conduct nationally competitive energy-related research and to develop science and engineering manpower to meet current and future needs in energy related areas. Most of the research clusters that have graduated from the DOE EPSCoR program after six years of funding have found alternate funding for continuing the research activity. This demonstrates that the research clusters funded by EPSCoR are becoming competitive. In addition, EPSCoR grants are supporting graduate students, undergraduates and postdoctoral fellows, and encouraging them to be trained in world-class research at DOE national laboratories. The work supported by the EPSCoR program impacts all DOE mission areas including research in materials science, chemical science, biological and environmental science, high energy and nuclear physics, fusion energy science, advanced computer science, fossil energy science, and energy efficiency and renewable energy science.

Scientific Challenges:

Initially only nine states were awarded implantation awards, which left many of the designated states without any DOE EPSCoR funding. To accommodate participation from a larger number of states in the program and to leverage the state-of-the-art unique capabilities of the national laboratories, a State-Laboratory partnership program was initiated in FY98. As a result of this program, approximately 28 partnership awards were approved in FY98 and FY99. In FY00 and FY01 twenty additional State-Laboratory partnership awards were funded in response to solicitation number 99-21. In FY03 another solicitation was issued and in response to this solicitation ten State-Laboratory partnership awards were made in FY04, and an additional four are expected to be made in FY05. This component of the program has successfully increased the number of states receiving funds from DOE EPSCoR program. The program continues to meet the challenge of providing a balance between the implementation awards and the Laboratory-State partnership awards.

Funding Summary: BY EPSCoR STATES

(**Dollars in Thousands)**

	FY 2003	**FY 2004**	**FY 2005 Estimate**
Alabama	946	987	735
Alaska	0	0	0
Arkansas	205	140	146
Delaware*	-	-	0
Hawaii**	0	0	0
Idaho	100	98	102
Kansas	881	547	695
Kentucky	1224	107	224
Louisiana	287	272	284
Maine	0	0	0
Mississippi	685	398	667
Montana	580	515	375
Nebraska	1,155	0	120
Nevada	1,146	0	0
New Mexico**	0	135	135
North Dakota	137	410	406
Oklahoma	339	275	135
Puerto Rico	435	375	375
South Carolina	781	454	316
South Dakota	0	125	125
Tennessee*	-	-	0
Vermont	1,064	877	709
US Virgin Islands*	-	-	0
West Virginia	1,405	248	291
Wyoming	130	130	270
Technical Support	222	80	60
Other***	0	1,500	1,503
Total	11,722	7,673	7,673

* Delaware, Tennessee, and US Virgin Islands became eligible for funding in FY 2004.
**Hawaii and New Mexico became eligible for funding in FY 2002.
***Uncommitted funds in FY 2004 and FY 2005 will be competed among all EPSCoR states.

SBIR contribution is not included in the Funding Summary Total above.

SBIR	321	222	222