“Spin Doctors” Look to Revolutionize Information Storage and Electronic Devices

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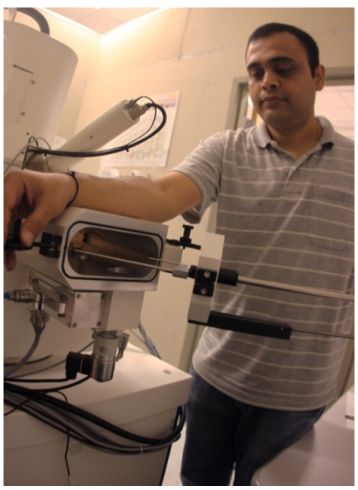
The Kentucky NSF EPSCoR is supporting a major initiative to create a Center for Advanced Materials (CAM). More than $5 million of state, federal (#0814194) and institutional support will be invested through 2013 to attract outstanding research faculty and students to Kentucky to create and study novel materials.

CAM was conceived of about five years ago as a center of excellence focused on materials research that would involve academic institutions across Kentucky. Creating new materials and understanding their properties is a first step, but applying those properties to engineer new devices and technologies is equally important. Increasingly, research needs to be coordinated across multiple institutions and departments. A great example of this is provided by Vinayak Bhat, a Ph.D. student at the University of Kentucky (UK) making use of the CAM infrastructure to study the nanofabrication of materials and their magnetic properties.



Vinayak Bhat using the electron beam lithography instrumentation

Vinayak is mentored by CAM faculty participants, Drs. Lance De Long (UK Physics and Astronomy) and Todd Hastings (UK Electrical and Computer Engineering), who are collaborating with the support of a related Department of Energy research grant. Vinayak’s research involves creating nano-sized holes or “antidots” in different shapes and sizes in magnetic thin film materials to discover how their shapes impact the magnetic properties of the material. The antidots are created with electron beam lithography (EBL) instrumentation (purchased with EPSCoR support), which permits Bhat to systematically vary the antidot shape, size and spacing, which govern how electron spin waves propagate through the material. An ultimate goal of this research is to control the electron spin at the nanoscale to create more efficient and compact information storage devices to replace existing hard drives and other electronic devices, similar to the way the transistor revolutionized computing by replacing the vacuum tube.

Vinayak also had some other early breakthroughs by creating much faster “writing” routines for creating the antidot patterning with the EBL. “One of the major disadvantages of using EBL instrumentation to write magnetic bits is the amount of time it takes, but we’ve devised a novel procedure to write in two hours what used to take us two days,” Vinayak says.

But the story doesn’t end there. Vinayak also needed to understand and model his experimental ferromagnetic resonance (FMR) data using the theoretical results and computer code developed by another collaborator, Dr. Kirill Rivkin from Seagate Technologies. Vinayak first simulated the FMR response on a PC, and next on a powerful supercomputer at UK, with the help of Dr. R. Michael Sheetz and Vikram Gazula in the UK Center for Computational Sciences. Vinayak plans to publish several papers about his research, and complete his Ph.D. degree in the coming year.

The amount of coordination and interaction you need to successfully complete cross-disciplinary, interdepartmental research like this is pretty astounding. It requires outstanding and diverse faculty and students, access to facilities and equipment, assistance from computational experts, collaboration with industry and collaboration across research disciplines—from theoretical and experimental physicists to chemists and engineers. But that’s what KY NSF EPSCoR is all about—creating strong research infrastructure through coordinated and complementary investments. Investments in fundamental science become the foothold to new materials, technologies, devices, intellectual property, companies, industries, jobs and economic development.

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