Understanding heat flow at the nanoscale is the goal of new project

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Understanding the mechanisms responsible for thermal transport, or heat flow, between dissimilar materials at the molecular level is the goal of Virginia Tech College of Engineering researcher Scott Huxtable, who has received a National Science Foundation Faculty Early Career Development Program (CAREER) Award.

Huxtable, an assistant professor of mechanical engineering, recently secured the five-year CAREER grant, which is worth more than $400,000 and is the National Science Foundation's most prestigious award for creative junior faculty who are considered likely to become academic leaders of the future.

Huxtable will use laser techniques -- timed by the picosecond, or one-trillionth of a second -- to determine at the nanoscale how heat is transferred across the boundary between two materials. A primary focus of his project will be discovering what types of chemical modifications can be made to the surfaces of materials to control the flow of heat.

Understanding heat flow at this level could help engender the design of nanostructured composite materials capable of controlling thermal conductivity. "This research could impact a wide variety of technologies," said Huxtable, who began studying nanoscale thermal transport as a graduate student at the University of California at Berkeley.

One example would be improved design of thermoelectric coolers,

which offer distinct advantages over conventional refrigerators and other cooling devices: they have no moving parts to break down and do not use harmful chemicals, such as ozone-depleting CFCs. However, thermoelectric devices are still highly inefficient. Better control of thermal conductivity could lead to the development of high-efficiency coolers.

Managing the tremendous amount of heat generated by power electronics is another anticipated result of thermal transport research. "A severe side-effect of the continual miniaturization of power electronics devices, including computers and cell phones, is a dramatic increase in the heat generated," Huxtable said. "This is becoming the limiting factor in device performance." Controlling thermal transport at the nanoscale could help minimize the problem.

Composite materials design could also get a boost. The tiles on the exterior of the Space Shuttle, for example, must be made from insulating materials capable of extremely low thermal conductivity. "The engineering community is always trying to create materials with properties at the thermal extremes," Huxtable said. "Nanostructured materials are a new approach to achieving both high and low conductivity composites."

Every CAREER project includes an educational component and Huxtable's is twofold. In a partnership with the Young Scholars Program in Utica, N.Y., which provides tutoring for underprivileged students from area high schools, he plans to bring two students to his lab each year "for a summer of research and learning. These students will be mentored in hopes that they will be motivated to attend college and to pursue degrees in science or engineering." He also is developing a new course on nanoengineering to teach at Virginia Tech.

Huxtable received his bachelor's degree from Bucknell University and

his master's and Ph.D. from the University of California at Berkeley. He conducted post-doctoral research in materials science, focusing on thermal transport, at the University of Illinois at Urbana-Champaign before joining the Virginia Tech faculty in 2003.

Source: Virginia Tech