**$14.4 MILLION**

DOE Funding at Vanderbilt in FY 2020

Vanderbilt research is helping to shape the future of American manufacturing

Vanderbilt is playing a key role in the multistate, $259-million Institute for Advanced Composites Manufacturing Innovation (IACMI) that is led by the University of Tennessee–Knoxville. The institute is funded by the Department of Energy (DOE) and is developing cost- and energy-efficient composite materials and technologies for high-volume production industries, such as automotive manufacturing. Much of Vanderbilt’s work for the institute is taking place at the Laboratory for Systems Integrity and Reliability. The goal of Vanderbilt’s work is to develop systems that automatically diagnose and fix quality control issues in composites manufacturing processes, including 3D printing, recyclable composites, and carbon fiber production. Vanderbilt has designed and deployed a Mobile Lab composed of state-of-the-art instrumentation and data analytics tools to address the needs in manufacturing quality control of its composites institute’s partners across the country.

**Partnering with Oak Ridge National Laboratory**

Oak Ridge National Laboratory (ORNL) is the largest national laboratory in DOE’s system. Vanderbilt is one of the UT–Battelle Core University Partners, a select group of seven southeastern universities that work closely with ORNL to jointly appoint faculty with common scientific interests, support collaborative research, train graduate students, and provide regional support for ORNL in the state of Tennessee. Padma Raghavan, vice provost for research, serves as Vanderbilt’s representative on the UT–Battelle Board of Governors, which oversees management of ORNL and works closely with ORNL leadership to promote collaborations.

Jason Valentine, associate professor of mechanical and electrical engineering, serves as the core university liaison with ORNL. Vanderbilt and ORNL are strongly committed to their ongoing research partnership. Current activities by Vanderbilt researchers at ORNL include use of the Spallation Neutron Source, the nanotechnology laboratories, and the TITAN and SUMMIT supercomputers for engineering, chemistry, physics, biochemistry, and cell biology research. These growing collaborations leverage our complementary strengths and have the potential to drive innovation and address challenges of national importance.

In tandem with ORNL, an engineering professor, whose research involves building statistical models of whole brain data sets, has received a competitive research grant from Oak Ridge Associated Universities—a consortium of American universities that provide innovative scientific and technical solutions to advance national priorities in science, education, security, and health.

**Physics students win U.S. Department of Energy Research Fellowships**

Two graduate students in the Department of Physics and Astronomy have been awarded coveted DOE fellowships to advance their research. A third-year physics Ph.D. student received an Office of Science Graduate Student Research Fellowship to conduct part of his dissertation research in a DOE laboratory focusing on single-photon sources which can be used in quantum communications and possibly quantum computing. The second award was given to a first-year physics Ph.D. student, who received a Computational Science Graduate Fellowship in overall support of her dissertation research using computer programming to solve problems in scientific disciplines such as physics, biology, and chemistry.
Consortium for Risk Evaluation with Stakeholder Participation

The Consortium for Risk Evaluation with Stakeholder Participation (CRESP) is one of the nation’s leading independent, interdisciplinary research groups focused on the waste management and environmental legacy from production of defense nuclear materials and nuclear energy. Vanderbilt leads this multi-university consortium of engineers, scientists, and legal and policy experts who have contributed over the past 25 years to the progress being made in addressing the nation's largest environmental liability. With the support of DOE, these nuclear waste experts leverage their knowledge to help the U.S. find safe ways to effectively manage nuclear waste from both defense nuclear materials production and civilian nuclear power sources. They see this as a critical component of environmental responsibility, including as a needed foundation for future nuclear power generating capabilities. The work at CRESP requires engineers, scientists, and policy experts to understand the complete life cycle of nuclear power generation, weapons production, and environmental impacts from nuclear weapons tests. Academic research through CRESP educates undergraduate and graduate students and post-doctoral scholars while carrying out foundational research needed to improve the efficiency and effectiveness of the cleanup program.

Experiments into amorphous carbon monolayer lend new evidence to physics debate, lay groundwork for future devices

An international team of researchers, including a professor of physics and engineering at Vanderbilt University, have confirmed that amorphous materials, like plastic, glass, and gels, are composed of a random network containing nanocrystallites, lending strong evidence to one side of the longstanding debate of whether these materials are truly continuous random networks or whether they have nanocrystallites embedded within them. The team's study, supported by DOE’s Office of Science, detailed the first successful experiments in growing, imaging with atomic resolution, and investigating the properties of two-dimensional amorphous carbon. This work not only provides answers but presents a physical, two-dimensional carbon material, distinct from the lauded graphene, with potentially promising applications, including anti-corrosion barriers for magnetic hard discs in future computers and for current collector electrodes in batteries.

Transforming grid management with risk metrics for renewables

Vanderbilt risk and reliability experts are part of a $3.25 million DOE ARPA-E-funded project to develop new machine learning algorithms that support decision-making in near real time on how system operators plan and operate the U.S. grid and leverage renewable energy sources, while minimizing the system risk. This is important because historical methods that predict supply and demand of the electricity market are not accurate. The price of electricity on the wholesale market fluctuates every minute based on demand and adding renewable energy to the mix greatly complicates matters. The goal of the project—Risk-Aware Market Clearing—is a blueprint for an end-to-end, data-driven approach that balances cost and minimizes system-level risk. Market clearing is the process that keeps the supply level to the demand with no leftover of either.

Advancing insights on black phosphorus as a material for future ultra-low power flexible electronics

Vanderbilt engineering researchers, with support from DOE and a DOE Office of Science facility, have shown for the first time that the reaction of black phosphorus to oxygen can be observed at the atomic scale using in situ-transmission electron microscopy (TEM). Black phosphorus is a crystalline material that is attracting growing research interest from semiconductor device engineers, chemists, and material scientists to create high-quality atomically thin films. From the perspective of a 2D layered material, black phosphorus shows promise for applications in next-generation flexible electronics that could enable advances in semiconductors, medical imaging, night vision, and optical communication networks. Unfortunately, black phosphorus is hard to make and hard to keep. It degrades quickly when exposed to air. The team is using the insights from the TEM experiments at atomic resolution in the lab to develop novel synthesis and preservation methods for black phosphorus.