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Structure and Dynamics of Vortex Matter

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The DOE Basic Energy Sciences Workshop on Basic Research Needs for Superconductivity identified grand challenges and research priorities for *discovery* and *use inspired* basic research to transform the US power grid to meet the needs of the 21^{st} century. Vortex matter research is central to this endeavor and helps support both fundamental and applied research. The science of vortex matter embodies the fundamental mysteries of vortex-vortex interactions in an inhomogeneous and anisotropic matrix. Understanding the complex phase diagrams and the dynamic responses that result from these competing effects is an outstanding challenge. Simultaneously, the prospect of controlling these interactions opens new horizons for basic research such as the development of a microscopic theory for vortex dynamics, exploration of vortex nucleation at magnetic and superconducting interfaces and designs for pinning a vortex liquid at high temperatures. This presentation will highlight ways in which nanotechnology based methodologies, dynamic vortex creep phenomena and powerful computer simulations play a role in enhancing our understanding of next-generation and new classes of superconductors.