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Materials research in energy and power for defense

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The demand for improved performance, increased power and energy densities, and reduced cost, size, and weight, drive the materials research focus of the Energy and Power (E&P) programs at the US Army Research Laboratory (ARL). An overview of ARL's relevant broad range, major programs will be presented, with emphasis on three key areas of materials research: 1) Chemical energy materials: electrochemical storage materials, materials for fuel cells, advanced battery chemistry materials, photoelectrochemistry materials; 2) Power science: WBG materials and devices, compact power materials and devices, science of thermal materials, alternative energy materials; and 3) Power integration: reliability of WBG materials and devices, integrated power/thermal device packaging. Examples from our advancements in each of the key areas employing numerous materials characterization and modeling approaches will be presented: Chemical energy materials: the development of novel "water-in-salt" electrolytes enabling high-voltage aqueous lithium-ion chemistries, derivation of the optimal substitution of the LCP achieving exceptional stability, high capacity, lower fade, and increased thermal stability; Power science: identified a transition layer at the SiC/silicon oxide interfaces of power field effect transistors relevant to their mobility parameters, development of ferrofluid-based stretchable magnetic core inductors, experimentally demonstrated and characterized mechanisms for nuclear isomer depletion that by-pass the slow nuclear decay transitions; and Power integration: identification of SiC voltage threshold instabilities leading to revised standards for device test and characterization, and others. Much of our research is performed in close collaboration with our partners from DOE and DoD labs, academia and industry. A brief summary of the various collaborative opportunities with ARL will be presented at the end.

Biography

Tsvetanka S Zheleva is the Associate Chief for the Energy and Power Division at ARL. Her expertise is in the areas of Applied Physics and Materials Science. She has published her research in over 150 publications in the areas of thin film physics, semiconductor materials and devices, interface engineering, structural analysis of device heterostructures. She holds 12 patents and her work are cited over 4000 times in peer reviewed journals and patent literature.

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