Rational Electrode Material Design Strategies for Capacitive Energy Storage

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LECTURE ABSTRACT

Electrochemical supercapacitors are important energy storage devices that bridge the gap between electrostatic capacitors and batteries. A critical component of supercapacitor design is the electrode material. In this talk I will discuss strategies that we have been developing to improve electrode material performance in conventional electrochemical supercapacitors and on-chip microsupercapacitor devices. Such strategies include direct electrode growth on current collectors for efficient electron transfer, enhanced surface areas and multimodal pore size distribution, electroactive materials with nearly metallic conductivity, two dimensional materials, and plasma and laser modification of materials. In the case of microsupercapacitors, the elimination of separator and proximity of the electrodes leads to faster ion kinetics, leading to significantly higher power devices. I will discuss approaches we have been developing to fabricate microsupercapacitors, particularly ones that combine chemistry and microfabrication. Our strategies have been applied to various types of electrode materials, including oxides, chalcogenides, and electroactive polymers. Integration of supercapacitors in energy harvesting and sensing devices will also discussed.

SPEAKER BIOSKETCH

Husam Alshareef is a Founding Processor of Materials Science and Engineering at King Abdullah University of Science and Technology (KAUST). He obtained his PhD at NC State University in 1996 followed by a post-doctoral Fellowship at Sandia National Laboratory, USA. He then embarked on a 10-year career in the semiconductor industry, holding positions at Micron Technology and Texas Instruments. There he worked on developing new materials and processes for the microelectronics industry. In 2009 he joined KAUST, where he initiated an active research group focusing on energy storage and electronics. The author of nearly 370 articles, he has nearly 70 issued patents. He has won the UNDP Undergraduate Fellowship, Seth Sprague Physics Award, NC State Dean's Fellowship, U.S. Department of Education Electronic Materials Fellowship, Sandia post-doctoral Fellowship (1996), SEMATECH Corporate Excellence Award (2006), two Dow Sustainability Awards (2011) and (2014), AH Shoman Award for Excellence in Energy Research (2016), and KAUST Distinguished Teaching Award (2018), and the Kuwait Prize for Sustainable and Clean Technologies (2018). He is a fellow of the Royal Society of Chemistry and IEEE Distinguished Speaker in Nanotechnology. He was co-chair for the 2014 Materials Research Society (MRS) Fall Meeting in Boston.

Selected Publications

HN Alsharef et al, Nano energy 49, 155-162, (2018)
HN Alshareef et al, Advanced Materials, 2018, 1803594
HNA Alshareef et al, Advanced Energy Materials 2018, 1870126 (2018)
HN Alshareef et al, Nano Letters 2018, 18 (2), pp 1506–1515
HN Alshareef et al, Nano Energy 45 (2018) 266–272.
HN Alshareef et al, Nano Letters, 2017, 17 (2), pp 1302–1311
HN Alshareef et al, Nano Energy 2017 (35), 331-440.

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