Nanomaterials for High-Performance 3D-Microbatteries

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Down scaling in the microelectronic industry has far outpaced advances in small-scale electrical power supplies. The absence of on-board power is a hinder to advances in many critical areas using microelectromechanical systems. Insufficient power from planar microbattery configurations inspires the search for the three-dimensional microbatteries using cheap and light micro-/nano-fabrication materials and techniques. Lithium and Li-ion batteries exhibit very high energy-density values, which are generally based on the performance of large cells with capacities of up to several ampere-hours. For microbatteries, the achievable power and energy densities do not scale favorably because packaging and internal battery hardware determine the overall size and mass of the complete battery to a greater extent. In addition, the rate and energy performance of current commercial batteries is limited by the two-dimensional (2D) bulk architecture of electrode materials, which possess relatively small electrode/electrolyte interfacial areas. Therefore, further improvements in advanced microbatteries are closely linked to the development of novel battery designs and materials.
One of the approaches to the achievement of significant cathode- and anode-volume gain and increased battery capacity by a factor of up to 25-40, is based on the use of a high-aspect-ratio perforated, rather than a continuous, substrates, thereby utilizing the dead volume of the substrate.
This presentation will outline achievements of TAU research group in the development of 3D-concentric microbatteries on perforated silicon and 3D printed polymer substrates. It then will give selected examples of recent progress in the development of new materials and techniques available for fabrication of 3D battery structures.

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