3D Printed Bionic Nanomaterials

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The development of methods for interfacing high performance functional devices with biology could impact regenerative medicine, smart prosthetics, medical robotics, and human-machine interfaces. Indeed, the ability to three-dimensionally interweave biological and functional materials could enable the creation of bionic devices possessing unique geometries, properties, and functionalities. Yet, most high quality functional materials are two dimensional, hard and brittle, and require high crystallization temperatures for maximally efficient performance. These properties render the corresponding devices incompatible with biology, which is three-dimensional, soft, stretchable, and temperature sensitive. Via custom-designed 3D printing approaches, we solve these dichotomies by: 1) using 3D printing and scanning for customized, hierarchical, and interwoven device architectures; 2) employing nanotechnology as an enabling route for overcoming mechanical discrepancies while retaining high performance; and 3) 3D printing a range of soft and nanoscale materials to enable the integration of a diverse palette of high quality functional nanomaterials with biology. 3D printing is a multi-scale platform, allowing for the incorporation of functional nanoscale inks, the printing of microscale features, and ultimately the creation of macroscale devices. This blending of 3D printing, novel nanomaterial properties, and 'living' platforms may enable next-generation 3D printed bionic nanodevices.