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Scalable Direct-Write Manufacturing and Applications in Nano and Bio Technology

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ABSTRACT:

Nanoscale manufacturing defines a paradigm shift in the advanced manufacturing domain and plays a pivotal role for several breakthrough technologies. With the eventual merging of top-down and bottom-up nanomanufacturing, the engineering community is at a threshold of emerging hybrid technologies. These include futuristic additive manufacturing (3D printing) to build hierarchical nano/micro structures. This research will focus on a novel hybrid nanomanufacturing technology that involves the combination of a proprietary direct-write method (bottom-up) and nanoimprint lithography (top-down) to selectively fabricate nano and bio structures. Multiphysics phenomena for studying nano-droplet behavior and substrate interaction are modeled using molecular dynamics simulations. The translation of direct-write manufacturing for fabricating flexible thin film transistors and green energy devices (solid oxide fuel cells) is discussed.

Biomanufacturing holds great promise in the engineering of novel therapeutics, smart transplantable devices and regenerative organs. Direct-write manufacturing is a non-contact (sterile) technology that can precisely deliver multiple chemistries of biomaterials at target locations. This research will also present the biomanufacturing of orthopedic device and cardiovascular stent coatings using the direct-write method. Polymeric barrier coatings are employed to tune the degradation of metallic biomaterials. The incorporation of amorphous calcium phosphate within the coatings has shown to promote osseointegration of biomedical implants. Further, direct writing is employed for attaining controlled release characteristics of multilayer coatings for drug eluting cardiovascular stents.

BIOGRAPHY:

Salil Desai is an associate professor with joint appointments in the Departments of Industrial and Bioengineering at North Carolina A&T State University where he directs the Integrated Nano and Bio Manufacturing Laboratory. He holds adjunct faculty appointment at the Wake Forest University Institute for Regenerative Medicine and is affiliated with the Joint School of Nanoscience and Nanoengineering. Desai's expertise is in the areas of nano/micro and bio manufacturing with applications in semiconductor electronics, drug delivery, and green energy devices. His work includes multiscale and multiphysics modeling of nano and micro scale phenomena towards developing scalable nano/micro manufacturing processes.

For his work, he has been the recipient of several prestigious awards including the National Science Foundation Career Award, Outstanding Young Investigator awards from the Society of Manufacturing Engineers, Institute of Industrial Engineers, and American Society of Engineering Education and others. He has also received young faculty awards from Oak Ridge National Laboratory and the Department of Defense. His research has been sponsored by the National Science Foundation, the Department of Defense, the Department of Energy and industrial partners.

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