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Multi-material nanoscale 3D fabrication based on femtosecond projection technology

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Abstract: A major challenge in nanotechnology is to fabricate complex 3D structures with desired materials. Despite the many great efforts, the material choices are still largely limited to polymeric materials or metals. A fabrication solution for a wider class of materials without compromising the existing structural complexity, nanoscale feature sizes, and material functions remains a critical challenge. In this seminar, I will present our recent works on the parallelization of ultrafast lasers for 3D nanofabrication, achieving a record setting resolution (20 nm), laser patterning rate (300 mm^3/hr), and wide material library. Specifically, an arbitrarily programmable femtosecond light sheet is generated based on the principle of spatial and temporal focusing to perform parallel material processing. We first demonstrate the use of the femtosecond light sheet to perform micro-laser machining on different materials, and next to fabricate complex 3D structures via two-photon polymerization. Lastly, by combining the femtosecond light sheets and swellable hydrogels, we further demonstrate a greatly expanded material library to include metals, metal oxides, semiconductors, dielectric materials etc. This has enabled the fabrication of nanometer-scale 3D functional devices. Our new methods provide an effective and low-cost solution to scale-up the fabrication of functional micro- and nano-structures (~\$1.5/mm^3). This means our technology may play a large role in fields such as healthcare, clean energy and water, computing, and telecommunications.

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Biography:

Dr. Shih-Chi Chen is a Professor in the Department of Mechanical and Automation Engineering at the Chinese University of Hong Kong. He received his B.S. degree in Mechanical Engineering from the National Tsing Hua University, Taiwan, in 1999; and his S.M. and Ph.D. degrees in Mechanical Engineering from the Massachusetts Institute of Technology, U.S., in 2003 and 2007, respectively. Following his graduate work, he entered a post-doctoral fellowship in the Wellman Center for Photomedicine, Harvard Medical School, where his research focused on biomedical optics and endomicroscopy. From 2009 to 2011, he was a Senior Scientist at Nano Terra, Inc., a start-up company founded by Prof. George Whitesides at Harvard University, to develop precision instruments for novel nanofabrication processes. His current research interests include ultrafast laser applications, biomedical optics, precision engineering, and nanomanufacturing. Dr. Chen is a Fellow of Optica (formerly OSA), Fellow of American Society of Mechanical Engineers (ASME), Fellow of International Society for Optics and Photonics (SPIE), and members of the American Society for Precision Engineering (ASPE) and Hong Kong Young Academy of Sciences (YASHK). He currently serves as the Associate Editor of ASME Journal of Micro- and Nano-Manufacturing, IEEE Transactions on Nanotechnology, and HKIE Transactions. In 2003 and 2018, he received the prestigious R&D 100 Awards for developing a six-axis nanopositioner and an ultrafast nanoscale 3-D printer respectively.