MHz frequency ultrashort laser material processing and nano-synthesis

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Abstract
Mega Hertz (MHz) pulse-frequency femtosecond (fs) laser–matter interaction is an under explored area in ultrashort laser material processing. Our recent research in this parameter range has led to interesting discoveries. The most interesting finding is that various types of nanomaterials can be generated by direct ablation of solids with MHz pulse-frequency femtosecond laser, at room temperature and atmospheric pressure. This process is unique in many ways: it is a sing-step synthesis; the precursors can come from a wide range of materials, including semiconductors, metals, alloys, ceramics, glasses, polymers and natural materials; and the generated nanomaterials are novel in terms of structures and chemical compositions. With assist gases and catalysts, the same method was also used to synthesize attractive nanomaterials, such as nanoplatelets, nanorods and nanotips.

Another important finding is that a few novel nanomaterials were generated through this method. Nanoalloys of immiscible metals was created by ablation of mixed metal microparticles. Natural materials, such as rice husks and egg shells, have been converted into nanoceramics. Most solids can be converted into nanoparticles-network, which is a free-standing, sol-gel-like, integrated three-dimensional nanomaterial. The porous structure of the nanoparticle network gives raise to enhanced optical properties and biocharacteristics. The optical enhancement can be used for photovoltaic and other light energy conversion applications. Ongoing experiments shows that the nanoparticle-networks demonstrated excellent properties as a platform for DNA biosensing and possesses vital characteristics for building tissue scaffold.

MHz frequency fs laser is also a viable tool for nanostructuring. For instance, 3D microstructures can be constructed from PDMS resins and thin oxidized/amorphousized silicon can be generated by irradiating crystalline silicon with carefully controlled fluency. The former shows potentials in building 3D PDMS-based microdevices while the latter could be used for the fabrication of thin film solar cells.

Biography of Speaker
Dr. Venkatakrishnan graduated with Ph.D in Mechanical and Aerospace Engineering from Nanyang Technological University (NTU), Singapore. He is currently working as Associate Professor at Department of Mechanical and Industrial Engineering, Ryerson University, Ontario. Before that, He worked as Strategic R&D Manager in Xsil Ltd, a European semiconductor manufacturer, and as Research Fellow/group leader at (NTU). His research interests focus on short
pulse laser ablation, laser micro manufacturing for semiconductor and microelectronics devices, and laser applications in nanoscale manufacturing. Recently, he directed her research efforts towards maskless fabrication and laser synthesis of nanomaterials and its applications in as photovoltaic energy conversion, biomedical analysis and tissue engineering. He has more than 90 publications in peer reviewed journals (H-Index 16). He also holds 8 US patents and 1 world patent.