

TECHNOLOGY DAY

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Multiphoton 3-D laser microwriter with a sub-nanosecond laser

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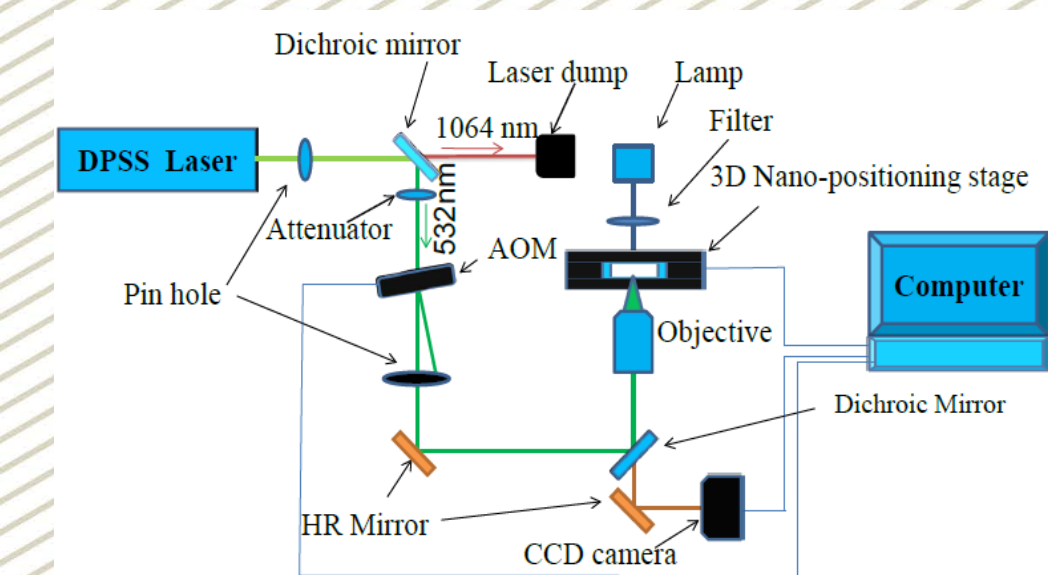


Fig.(1) Schematic of the system

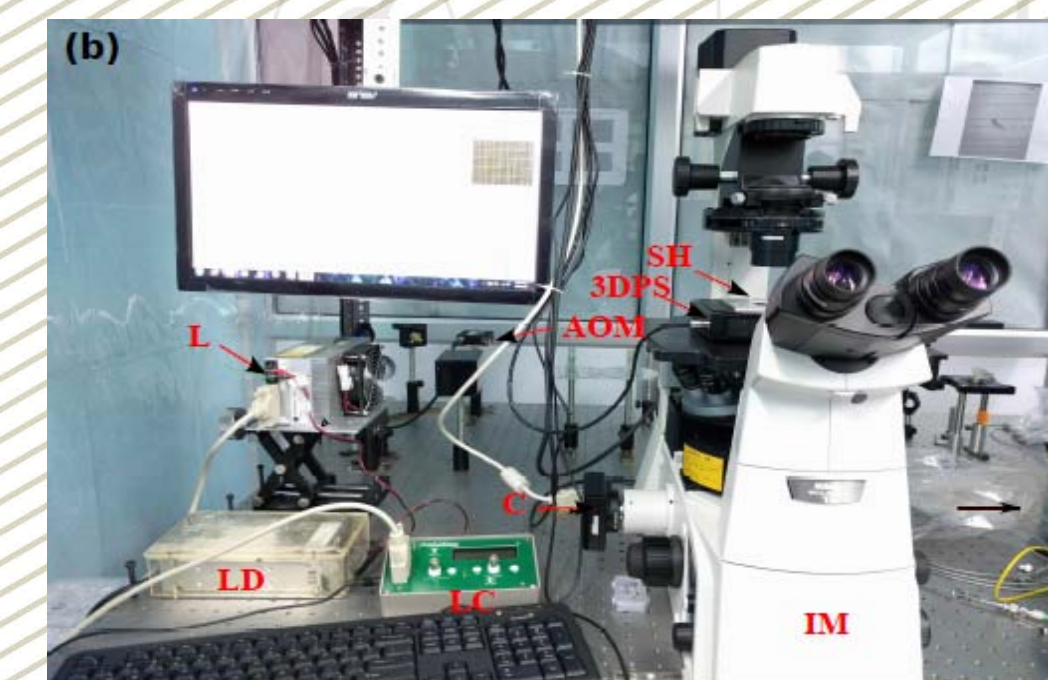


Fig.(2) System photograph

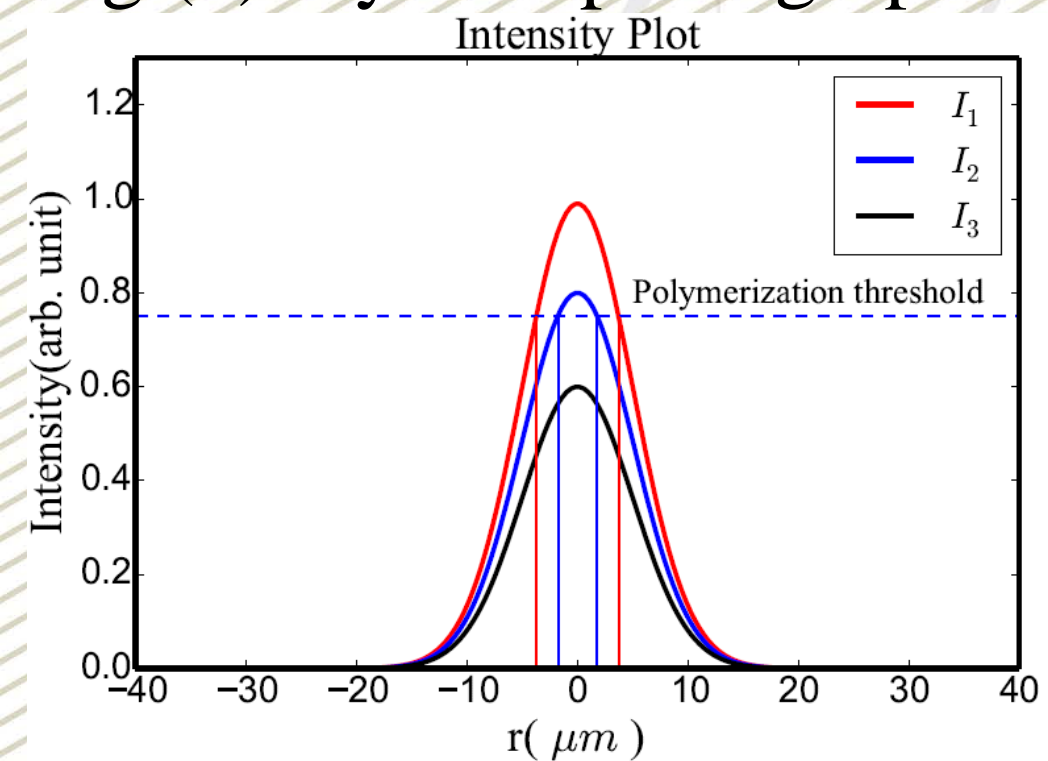


Fig.(3) Sub-diffraction limited resolution

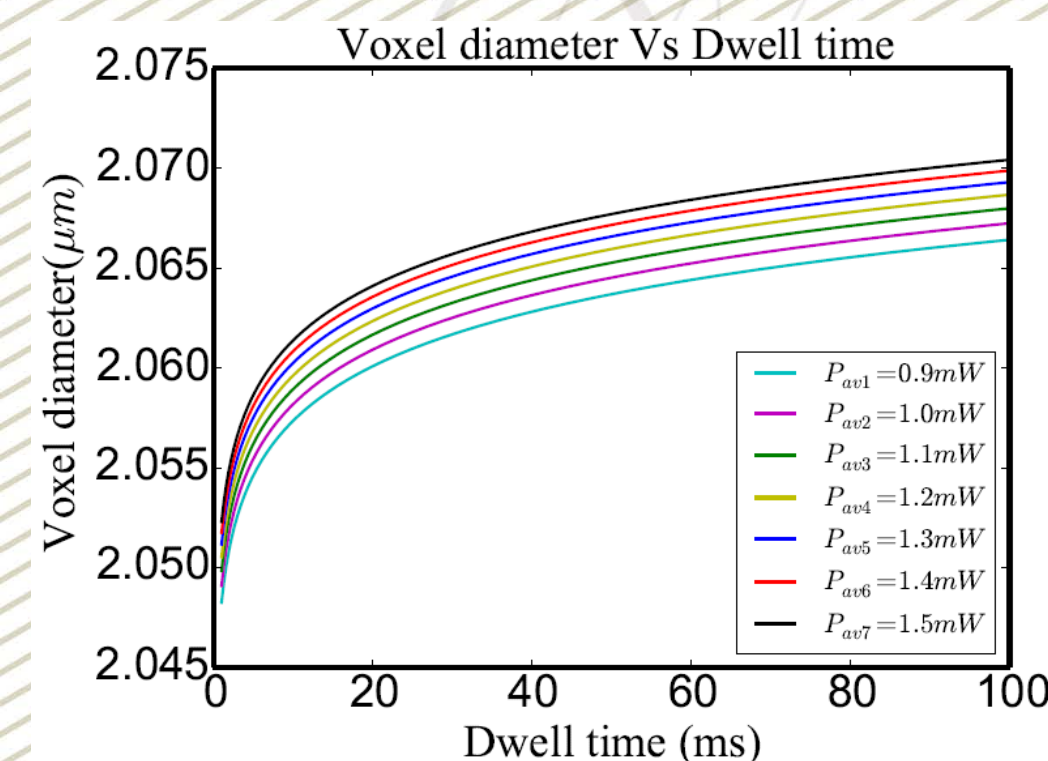


Fig.(4) Voxel diameter versus dwell time & laser power

A two-photon laser writing system with sub-micrometer resolution has been developed. It uses a sub-nano second laser and commercially available photoresist and enhancer materials. This system is an inexpensive alternative with similar capabilities as a femtosecond based laser writer. It has much higher capabilities for 2-D structuring in terms of aspect ratio than conventional 2-D laser micro writers .

Applications / Markets:

- **Micro-optic and photonic devices:** Microlenses, gratings, 3D photonic crystals, waveguides, sensors, microring-resonators, metamaterials.
- **Microfluidic devices:** Filter elements, capillary pump, channels.
- **Micro rapid prototyping:** Micro lens holder
- **Life sciences :** Microneedles, scaffolds and boimemitics for tissue engineering , drug-delivery devices.
- **MEMS/NEMS:** Micro-springs, micro gears, micro rotators.
- **Data storage:** 3D optical data storage.
- Electronic circuit board manufacturing.
- Microwave hybrid micro integrated circuits.

Thus system has potential applications in the above mentioned fields and new applications are being explored. Here, we have used inexpensive sub nano-second laser and commercial available photoresists and photoinitiators for micro-fabrications. This clearly lays out new route for low cost fabrication systems and moving towards industrial rapid production systems.

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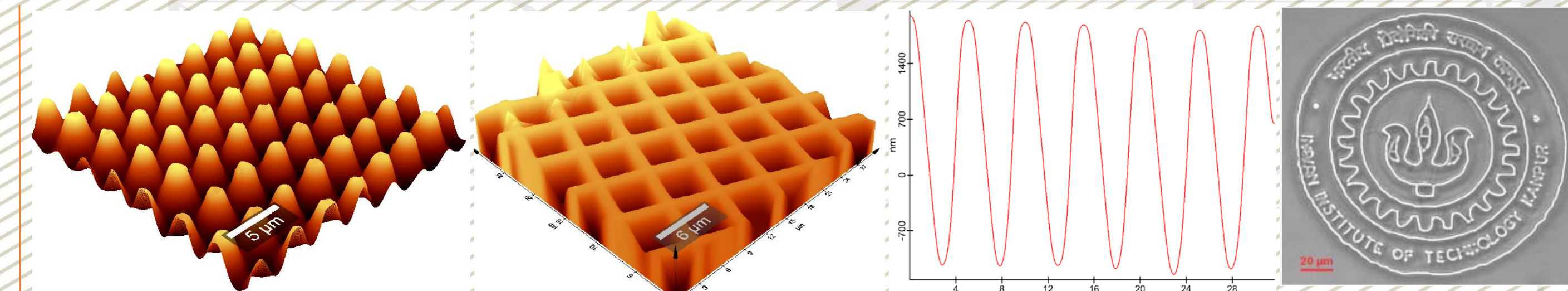


Fig.4 (a) 2D dots array (b) 2D grating (c) Line profile (d) IITK logo

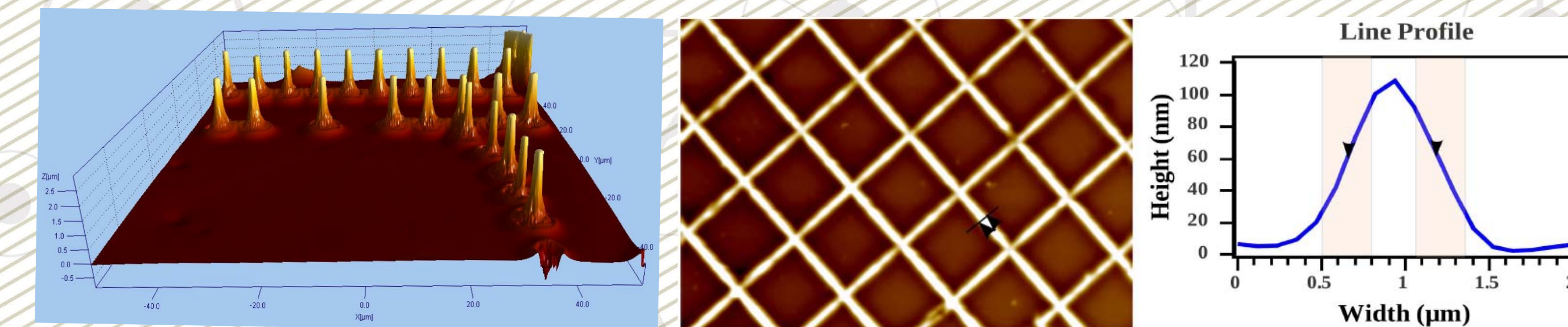


Fig.5 (a) Pillars array (b) 2D grating (c) Line profile

System details:

- **Laser:** Wavelength - 532 nm, pulse energy~0.2μJ, pulse width~700 ps, Rep rate 1-10 Khz.
- **Materials:** Negative photoresists as SU-8, ARN-4340 with photoinitiator.
- **Writing resolution:** > 500 nm, depth few micro meters.
- **Stage:** Piezo electric XYZ(3-D) nano-positioning stage with a travel range of 200 μm × 200 μm × 200 μm and writing speed up to 2000 μm/s for fabrication of 3D micro-structures.
2D motorized stage with travel range of 7.5cm × 12cm and writing speed up to 2 mm/s for large area fabrication.
- **Software:** LabView software is used to simultaneously control the motion of piezoelectric stage and AO modulator(laser shutter).

Novelty of technology: This technology has unique capability that can be employed for fabrication of highly complex 3-D micro-structures with resolutions beyond diffraction limit.

Summary: An inexpensive two photon 3-D laser writing system as an alternative to femtosecond based laser writers with sub-micrometer resolution based on sub-nanosecond pulsed laser has been developed.