Detailed Specifications for Tender No. 201700267

Multiphoton Polymerization based 3D Micro-fabrication System

Scope: Supply, Installation, Commissioning and Training of the system having the following specifications:

Multiphoton Polymerization Based 3D Laser Lithography System capable of 3D micron and sub-micron large area structuring into a broad range of photoresists using multiphoton polymerization for producing arbitrary shaped 2D, & 3D features. The writing principle must be based on multiphoton polymerization.

<table>
<thead>
<tr>
<th>Sr</th>
<th>Parameters</th>
<th>2PP process</th>
<th>Ablation/Direct writing</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Materials</td>
<td>photoresist</td>
<td>SZ2080, ORMOCER</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Polymer, Glass, Silicon</td>
</tr>
<tr>
<td>2.</td>
<td>Structures</td>
<td>2D lines, 3D</td>
<td>Primarily Microchannel &amp;</td>
</tr>
<tr>
<td></td>
<td></td>
<td>woodpile</td>
<td>waveguides, Mach Zhender</td>
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<tr>
<td></td>
<td></td>
<td>structures,</td>
<td>interferometer, optical</td>
</tr>
<tr>
<td></td>
<td></td>
<td>predefined</td>
<td>attenuators</td>
</tr>
<tr>
<td></td>
<td></td>
<td>shape 3D</td>
<td></td>
</tr>
<tr>
<td>3.</td>
<td>Spot resolution</td>
<td>&lt; 300 nm or better</td>
<td>1 μm or better</td>
</tr>
</tbody>
</table>

Accessible Writing Area:

The system should be capable of micro/nano structuring over a large area of 150mm x 150mm x 50 mm or more.

POSITIONING SYSTEM

Total travel XYZ At least 150 x 150 x 50 mm
Accuracy XY ±400 nm or better
Accuracy Z ±300 nm or better
Resolution XY 1 nm or better
Resolution Z 3 nm or better
Max speed XY 50 mm/s or faster
Repeatability XYZ ±100 nm or better
XYZ orthogonality 10 arc sec
Position synchronized output yes
Mounted on a granite base with bridge yes

Minimum Writing Area without stitching: The following should be the minimal writing area without stitching at the best resolution (minimum feature size):
135x135 μm² or higher

Build Structure height capability: up to 500 μm or more
**Minimum Feature Size Expected:**
Minimum 3D lateral feature size: 500 nm or less
Minimum 2D lateral resolution: 350 nm or less
Minimum vertical resolution: 1600 nm or less
Material dependency to achieve above if any must be explicitly stated. A minimum feature sizes specification chart for each supported material may be provided.

**Laser beam positioning repeatability should be ±100 nm (2D) or better**

**Scan Speed:**
3D laser lithography should be possible at speeds of 500 µm/s or more at the best resolution (minimum feature size).

**Camera System:**
A high sensitivity camera system should be included for real-time monitoring of the writing process with the following minimum specifications:
- Operating wavelength: 500 nm – 600 nm
- On-axis vision: yes
- Lighting: Coaxial and back
- Matrix size: 1280 x 800 or better
- Resolution: 1 µm or better
- Speed: 10 fps or more
- Live fabrication preview: yes
- Fabrication recording: yes
- Use camera to find focus: yes
- Superposition with fabrication algorithm preview: yes

**Laser**
A suitable laser of 1024 - 1034 nm with more than 5W. Rep rate should be tunable 1MHz with pulse duration of < 300 fs – 8 ps tunable.

**Laser source**
- Wavelength: 1024 nm – 1034 nm
- Average power: Equal or more than 5 W
- Repetition rate: 1 MHz (tunable down to 70 kHz or below)
- Pulse duration: Less than 300 fs (tunable up to 8 ps)
- Pulse energy: More than 80 µJ
- Beam quality $M^2$: At least 1.2
- Beam diameter: Not less than 1 mm
- Polarization: linear
- Cooling: Air cooling
- Footprint: Less than 760 x 350 x 200 mm
- Pulse to pulse stability: < 0.5 % rms over 24 hours or better
**EXTERNAL POWER CONTROL DEVICE**

<table>
<thead>
<tr>
<th>PC controlled</th>
<th>Yes</th>
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<tbody>
<tr>
<td>motorized</td>
<td>Yes</td>
</tr>
<tr>
<td>Operating wavelengths</td>
<td>1024 nm – 1034 nm and 512 nm – 517 nm</td>
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<tr>
<td>Power calibration</td>
<td>yes</td>
</tr>
</tbody>
</table>

**FOCUSSING OPTICS**

<table>
<thead>
<tr>
<th>Numerical aperture</th>
<th>0.42 or better</th>
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<tbody>
<tr>
<td>Resolving power</td>
<td>1 μm or better</td>
</tr>
<tr>
<td>Working Distance</td>
<td>20mm or more</td>
</tr>
<tr>
<td>Operating wavelengths</td>
<td>1024 nm – 1034 nm and/or 512 nm – 517 nm</td>
</tr>
</tbody>
</table>

**BEAM DELIVERY OPTICS**

- Dielectric mirrors reflection: 99% or more
- Wavelengths: 1024 nm – 1034 nm and 512 nm – 517 nm
- Wavefront distortion: λ/8 or better
- Clear aperture: Not less than 25 mm

**HARMONICS GENERATOR**

<table>
<thead>
<tr>
<th>Wavelength</th>
<th>512 nm – 517 nm</th>
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</thead>
<tbody>
<tr>
<td>Conversion efficiency</td>
<td>At least 45 %</td>
</tr>
<tr>
<td>Beam quality M²</td>
<td>At least 1.4</td>
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<tr>
<td>Automated switching between fundamental and second harmonic</td>
<td>yes</td>
</tr>
</tbody>
</table>

**POWER METER**

<table>
<thead>
<tr>
<th>Max. measurable power</th>
<th>6 W</th>
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<tbody>
<tr>
<td>Aperture</td>
<td>12 mm</td>
</tr>
<tr>
<td>Spectral range</td>
<td>0.19 – 20 μm</td>
</tr>
</tbody>
</table>

**Compatible Materials for fabrication:**

The system must support the 3D micro and nanofabrication in a wide range of photoresists, including negative-tone resins like SU-8 and acryl-based photoresists and positive-tone resins like AZ-photoresists. Any other resists or materials in which the 3D structures can be fabricated should be clearly specified. Datasheets and MSDS documents of the supported materials, including proprietary materials, if any, may be included.

**Computer System:**

A current generation computer system must be provided with the system and must be capable of smoothly running the software required for the micro-fabrication. The computer must be integrated with relevant software and all the relevant installation and operation procedures must be documented.

**Software:**

- An easy-to-use graphical user interface must be provided for operating the system, the whole writing process must be automated.
• The software must have access to all necessary hardware parameters for controlling fabrication process
• The system should be able to handle standard formats of 3D designs created by popular CAD programs, like FAB, FABx, DXF, STL, PLT, BMP, TXT, AMF, G-code created from software like Autodesk®, Blender, SolidWorks®.
• should control all system devices
• should control Laser firing, Laser power, Pulse repetition rate,
• should control Power attenuation with motorized attenuator
• should control Automatic and manual positioning stage control
• The system should be equipped with a function that finds the interface between the resist and substrate automatically, in order to make sure that the written structures are anchored well to the substrate.
• Alignment relative to markers: The software must allow for flexible positioning and writing relative to predefined markers in any plane.
• Remote control: The system must enable remote control from an office workstation.
• Software upgrades must be provided during the warranty period of the system.

Sample Holders & Consumables:
• Suitable sample holders (Up to 50 x 50 mm)- 3 Nos for standard microscope glass-slides should be provided with the system. Sample holder has a possibility to fine tilt the sample in two coordinates.
• Fine XY tilt for sample holder and integrated backlighting should be provided
• Vacuum suckers for sample holding
• Adequate variety of sample holders for different sizes, etc with full details of the holders must be included.
• Photoresist, along with other chemicals required for their processing, for obtaining the minimum feature size (one set)

Safety:
The system should be certified for safety standards for operation like CE regulations or equivalent.

Documentation
Complete and detailed documentation of both software and individual hardware components must be provided to enable modifications or adaptations (in consultation with the manufacturer)

List of installations worldwide
A list of installations worldwide is to be provided along with a list of publications where the system has been used in the publication of the paper. At least FIVE of such similar systems must have been installed worldwide by the bidder.

Installation, Acceptance and Training
The system should be installed at the installation site indicated by the buyer, after installation acceptance tests should be run to confirm the specifications of the system. An extensive user training should be included in the technical offer. The system must be qualified for use with photoresists (list approved during system development stage) provided during the installation.

Warranty and Service
The equipment will be covered by warranty for one year included in the offered price. The after-sales service will cover software updates after the installation, telephone support
guaranteed by appropriate technical personnel and in severe cases service intervention will take place at IIT Mumbai

**Demonstration sample**

The bidder must fabricate & submit samples with the following specifications and a corresponding report in the technical bid.

Substrate: fused silica glass, 2-3 mm thickness, 1 inch diameter. Fabricate 3 circles (800 um diameter) hatched with: lines (5 um period), lines grid (10 um period), dot array (5 um period).

For 2PP: samples to be submitted with minimum 3D lateral feature size: 500 nm or less

Height of less than 1600nm for 3D samples.  
Minimum 2D lateral resolution: 350 nm or less,

The same submitted Structure needs to be fabricated again during the time of installation & commissioning of the system at IIT Bombay, guaranteed & demonstrated all its features & parameters to the buyers as agreed by the bidders in their Technical Bid.

**Delivery Period**  
180 days after placing of PO.