High Resolution 3D Laser Technologies and Applications

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One of the rapidly advancing femtosecond laser technologies is three-dimensional micro- and nanostructuring by two-photon polymerization (2PP) technique [1-5]. In our work, we apply near-infrared Ti:sapphire femtosecond laser pulses (at 800/780 nm) for 3D material processing. When tightly focused into the volume of a photosensitive material (or photoresist), they initiate 2PP process by, for example, transferring liquid into the solid state. This allows the fabrication of any computer-generated 3D structure by direct laser "recording" into the volume of photosensitive material. Because of the threshold behavior and nonlinear nature of the 2PP process, a resolution beyond the diffraction limit can be realized by controlling the laser pulse energy and number of applied pulses. Figure 1 shows two scanning electron microscope images of 3D microstructures fabricated by 2PP technique. One can see the strength of this technology and envision many potential applications. In our contribution, we will report on recent advances of this technology and future short- and long-term prospects. A comparative analysis of the structuring properties of various photosensitive materials will be presented. Many different applications will be discussed.

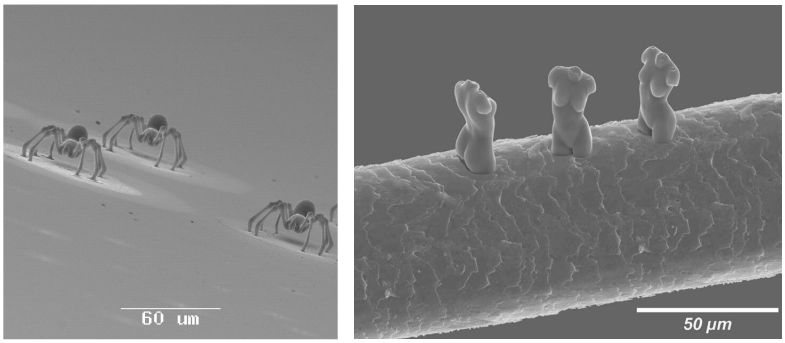

Figure.1. **A scanning electron microscope (SEM) image of a microspider-array and Venus micro-models fabricated by 2PP technique.**

[1] S. Maruo, O. Nakamura, and S. Kawata, *Opt. Lett.* **22**, 132 (1997).
[2] S. Kawata, H.-B. Sun, T. Tanaka, and K. Takada, *Nature* **412**, 679 (2001).
[3] B. H. Cumpston, S. P. Ananthavel, S. Barlow, D. L. Dyer, J. E. Ehrlich, L. L. Erskine, A. A. Heikal, S. M. Kuebler, I.-Y. S. Lee, D. McCord-Maughon, J. Qin, H. Rockel, M. Rumi, X.-L. Wu, S. R. Marder, and J. W. Perry, *Nature* **398**, 51 (1999).
[4] J. Serbin, A. Egbert, A. Ostendorf, B. N. Chichkov, R. Houbertz, G. Domann, J. Schulz, C. Cronauer, L. Frohlich, and M. Popall, *Opt. Lett.* **28**, 301 (2003).
[5] J. Serbin, A. Ovsianikov, and B. N. Chichkov, *Opt. Express* **12**, 5221 (2004)

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