

## **Laser Micromachining for Microfluidic, Microelectronic and MEMS Applications\***

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Laser micromachining of dielectrics and metals is a versatile fabrication and repair tool for applications in micro-fluidics, microelectronics and MEMS. Issues such as ablation threshold, ablation rate, incubation of damage at subthreshold fluences, edge resolution, debris creation and residual substrate damage are all important in determining the suitability of this technique for these applications. An extensive study is being carried out on drilling of holes in glasses of interest to microfluidic systems using both nanosecond UV laser pulses at 266 nm and femtosecond pulses at 800 nm. The drill rate and maximum ablation depth has been measured for various holes sizes ranging from 25 to 100  $\mu\text{m}$  in diameter. The resultant morphology is measured using an optical microscope and a scanning electron microscope showing that redeposition and loss of beam fluence down the hole limits the maximum hole depth for a given entrance laser fluence. The results indicate that, in some cases at deep depths near the end point of the hole, the shape may no longer be round. Cracking around the entrance of the hole is also observed with nanosecond drilling and a new technique involving heating of the substrate during the laser interaction is being studied to try to reduce the degree of cracking. Redeposition of glass around the entrance of the drilled hole, which complicates applications where contact must be made to an adjoining surface, is another issue. In order to minimize redeposition, techniques of using a protective sacrificial layer are being investigated. In particular, the use of a protective tungsten thin film which can be stripped off, taking the overcoated debris with the film, is being investigated. In order to understand the microscopic processes occurring within the material and to predict the expected ablation thresholds, ablation rates and residual damage to the material structure, a molecular dynamics simulation code is under development to model the ablation of silicon and the ablation of glasses. Current experimental results and theoretical understanding will be presented in this paper.

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