

## Confining intense laser-matter interaction for the processing of transparent dielectrics

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Transparent dielectrics such as glass are becoming increasingly used in nanotechnologies. However, most of the intended use require deep drilling, which is extremely demanding for lithography. In this framework, ultrafast laser pulses provide the benefit of being able to process materials in 3 dimensions from the bulk itself. A single laser pulse can be used to generate an extremely high aspect ratio nanochannel. The process relies on generating a high density plasma along a cylinder with nanometric diameter, whose relaxation generates in turn a microexplosion opening a void even inside the hardest materials.

With the objective of generating nanometric channels inside transparent dielectrics with high efficiency, a key enabling tool is to deposit energy within glass on the smallest possible diameters. We report several successful approaches to confine the interaction. For this, we used combination of pulse sequence, high angle focussing. We have demonstrated higher efficiency for nanochannel drilling with high aspect ratio and reduced heat affected zone. This allowed us to generate nanochannels in glass with diameters close to 100 nm with a single laser pulse. The physics of the interaction will be discussed. Applications to stealth dicing of glass will be demonstrated. For the application to nanomachining of thick glass, we designed a new Bessel beam shaper which allowed us to cleave glass with up to 1 cm thickness after a single pass illumination.