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Exceptionally high aspect ratio micromachining with single femtosecond laser pulses BRIAN K. CANFIELD, TREVOR S. BOWMAN, ALEXANDER TEREKHOV, LINO COSTA, DEEPAK RAJPUT, WILLIAM H. HOFMEISTER, LLOYD M. DAVIS, University of Tennessee Space Institute — Traditional microchannel laser machining techniques involve overlapping focal spots from many laser pulses by scanning the substrate. However, this procedure is both time-consuming and allows thermal and mechanical damage to accumulate, degrading the quality of the channel profile and surrounding substrate. We have developed an alternate means of machining a very long microchannel in fused silica with a single pulse, using combinations of cylindrical lenses and an aspheric lens to reshape a near-Gaussian beam into a tight line focus. For microfluidic applications, channels should possess near diffraction-limited cross-sections just a few microns deep while being up to 2 mm long. However, depending on the pulse energy, the extremely high peak fluences can induce nonlinear effects such as filamentation and self-focusing. These effects mayproduce unexpected features, including beam-path bifurcations and multiple foci that sometimes blend into exceptionally deep channel profiles. We demonstrate microchannels that range from 5 microns to more than 30 microns deep but are only about 1 micron wide along the entire channel length. We explore the underlying extreme physical processes that might yield such extraordinary results.

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