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The application of 193nm ArF excimer laser radiation to the fabrication of high-quality sub-micron relief gratings in Er/Yb-doped borosilicate glass using an interferometric system is presented. High quality relief gratings imprinted in silicate telecom glasses may find significant application in optical telecommunications or photonic band-gap fields in the near future. In particular, relief gratings applied to fibre or waveguide devices may provide high diffraction efficiencies over reduced dimensions compared with photorefractive gratings. Their straight-forward application to a wide range of materials and the single step imprinting process are additional advantages. The ablation of BK-7 borosilicate glass using 193nm excimer laser radiation produces high quality surface etching when compared to 248nm radiation, prompting the use of this shorter wavelength for the fabrication of high-quality sub-micron structures.

The grating fabrication apparatus uses a line-narrowed injection cavity 193nm excimer laser (Lambda Physic EMG 150), a cylindrical lens telescope to adjust the beam energy density on the substrate and a three-mirror modified Mach-Zehnder interferometer. The grating substrates were optical quality polished Er/Yb-codoped (3% and 5% oxide wt. respectively) borosilicate glass plates.

Single- and multi-pulse grating exposures were performed at low repetition rates (<1Hz) to avoid extensive thermal phenomena and plume screening, revealing the dynamics of fine-structure ablation. Gratings having periods of less than 500nm have been fabricated, with a peak-to-valley depth greater than 150nm. The dependence of the ablated grating groove thickness on the energy density and number of pulses was studied using diffraction efficiency measurements and AFM imaging. From these measurements, optimum machining conditions can extracted as a function of energy density and number of pulses and the dependence of the ablation threshold on the number of pulses can be evaluated. We observe that the grating thickness reduced for exposures with energy densities far from the ablation threshold and for a high number of pulses. This may be attributed to incubation phenomena in the exposed material. Relief gratings fabricated by 193nm excimer laser ablation are also imprinted on ion-exchange waveguide channels and preliminary results have been obtained.