In recent years, there has been an increasing interest in laser sources with a high pulse energy and high repetition rate in the shortwave infrared range (1.4–3 μm) for scientific and industrial applications. Compared to the 1 μm wavelength of established radiation sources, the longer wavelength offers fundamental advantages for some nonlinear conversion processes such as THz or soft X-ray generation. Moreover, pulse durations of only a few cycles per pulse are required for efficient frequency conversion, e.g., by generation of high harmonics (HHG). However, lasers based on thulium (Tm)-doped fibers or crystals emitting at 2 μm cannot directly generate these short pulse durations.

Great potential of MPC technology

With a Tm fiber laser from Fraunhofer IOF, it was possible to spectrally broaden pulse energies of 1.6 mJ at a repetition rate of 100 kHz at a wavelength of 1.9 μm in a krypton-filled MPC. With subsequent temporal compression, an overall transmission of 95 percent with pulse durations of 25 fs was achieved, corresponding to four optical cycles. These unique results demonstrate that the MPC technology can be transferred and has enormous potential in the short-wavelength infrared range. Furthermore, these results represent an important milestone on the path to efficiently generating soft X-rays in the water window. The R&D project underlying this report was carried out on behalf of the German Federal Ministry of Education and Research (BMBF) under the grant number 01DR20009A.

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