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Optical properties and damage thresholds of materials for high-peak-power LWIR laser applications

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Ultra-intense lasers in the long-wavelength infrared (LWIR) spectral region are particularly attractive to the areas of ultrafast and strong-field science, primarily due to favorable quadratic scaling of the ponderomotive potential with the laser wavelength, which benefits accelerator research. However, advancing LWIR lasers peak power faces significant challenges due to intensity-dependent effects, such as nonlinear refractive index changes, absorption in transparent optics, and laser-induced damage to optical components. These issues can potentially degrade laser performance.
While these properties are frequently studied using short-pulse lasers in the ultra-violet to mid-infrared wavelength range, their manifestation at longer wavelengths has not been extensively investigated. Consequently, there is a lack of reliable data on materials' nonlinear properties and laser damage thresholds under ultra-short LWIR pulses near a 9 μm wavelength.
In our research, we present the nonlinear optical properties and preliminary damage threshold measurements for selected transparent LWIR laser optics and mirrors. Experiments were conducted using a high-peak power 9.2 μm laser, switchable between 2 ps and 70 ps pulse durations. For damage threshold measurements, samples were characterized ex-situ using optical microscopy to estimate the damage areas, which scale linearly with the logarithm of pulse energy for near-Gaussian beams.

Working group

WG1 : Laser-driven plasma wakefield acceleration

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