Reliable femtosecond UV-DUV solid-state lasers for industry applications

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High-power femtosecond ultraviolet (UV, >300nm) and deep-ultraviolet (DUV, <300nm) lasers are crucial for precise micromachining applications. Due to the shorter wavelength, UV lasers can be focused on tighter spot sizes with shallow absorption depth. This allows for more precise material ablation with outstanding resolution and quality and with minimal heat-affected zones (HAZ). The ability to cut heat-sensitive polymers with minimum kerf width, low HAZ, and at high speeds is critical for OLED and other consumer electronics industries [1]. Femtosecond DUV lasers excel in glass processing, significantly reducing damage, cracking, and chipping in processed areas, eliminating the need for extensive post-processing [2]. The semiconductor industry [3], medical applications [4], UV-induced breakdown spectroscopy [5] highly benefit from femtosecond UV laser sources. Overall, the versatility and precision of femtosecond UV and DUV lasers make them integral to a wide range of industries and scientific applications.

Due to high application demand, there is considerable effort in laser development to increase laser power and repetition rate at UV and DUV wavelengths. A widely used and effective method for generating femtosecond UV light is sum frequency generation (SFG), starting from IR femtosecond laser light. While this process is conceptually straightforward, challenges arise when scaling to high UV power levels. The primary obstacles are dispersion, multiphoton absorption, and material damage. Overcoming these challenges is essential for advancing the field.

This presentation will address these key limitations and discuss the latest developments in harmonic generation up to the 5th harmonic from 1030 nm Yb-based laser, with a particular focus on the 3rd (343 nm) and 4th (257nm) harmonics. Critical factors such as system lifetime, beam quality, and warm-up time will also be explored, as they significantly impact the effectiveness and reliability of UV sources in applications like materials processing. By highlighting cutting-edge results and strategies, this presentation aims to provide a comprehensive overview of the progress in femtosecond UV and DUV laser technology and its practical applications.

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