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Review of UV laser and its applications in micromachining

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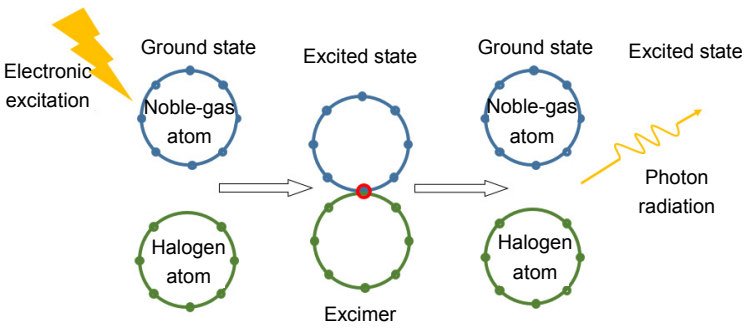

Schematic diagram of excimer laser generation.

Abstract: Ultraviolet(UV) laser with its short wavelength, high machining accuracy and cold processing property, has unique advantages in micromachining, and can effectively improve the manufacturing quality. Modern electronic industry has achieved a rapid development in recent years, and sets higher demands in fabricating. UV laser's progress and applications in electronic industry attracts are attracting broad attention. UV laser can process complex structures on almost any materials with flexible process and small heat-affected zone. It summarizes the development of UV laser. The fundamental principles and characteristics of excimer laser and diode pumped solid state laser are given, which are two major UV lasers used for micromachining. The development and applications of UV laser in the micromachining of semiconductor, optical element and polymer are introduced. It gives some prospects and forecasts about research in the further development.

According to different actuating mediums, UV lasers used for micro-machining are majorly classified into two categories, excimer laser and diode pumped solid state laser. The noble gases and halogen elements work as actuating medium in excimer laser. Under the excitation of high-energy electrons, the noble gas atom and halogen element atom combine into excimer. When these excited atoms return to the ground state, it emits energy of a characteristic wavelength. The wavelengths of excimer laser can vary from 126 nm (Ar_2) to 650 nm (Xe_2F). While in the diode pumped solid state laser, the photons generate from the diode. The origin photons are transmitted into the photonic crystal, where photons excite more photons of fundamental wavelength, which compose fundamental light. Then fundamental light penetrates into the nonlinear frequency doubling crystal, and changes into the second harmonic light with wavelength halved. After several frequency transformations, the origin light finally becomes the expected light of an ultraviolet wavelength.

During the process of laser machining, UV laser carries on processing to materials using the photochemical effects. When UV laser irradiates on the surface of materials, part of photons are absorbed by the electrons of surface. Owing to UV laser's single photon energy higher than that of chemical bonds between material atoms, the chemical bonds can be directly broken in irradiated area. The materials can be stripped from the surface in the form of gaseous atom or particle, to compete presupposed micro-machining. UV laser has been widely used in the fields of semiconductor, optical element and polymer, for its small heat-affected zone and high machining precision. Application status and developing prospects of UV laser are discussed in this review.

Keywords: UV laser; laser micromachining; semiconductor; micro-optical element; polymer

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See page 1169 for full paper.