

He Shield Gas in Excimer Laser MicroMachining

Excimer laser micromachining of polymers proceeds by the phenomenon of photablative decomposition. During ablation, molecular fragments in the range 50-500 a.mu. are ejected from the ablation zone with supersonic velocities, and form part of the audible shock wave and visible ablation plume where further molecular disintegration takes place. Momentum exchange with the surrounding atmosphere results in the redeposition of much of this material in a sooty-like deposit, mainly elemental carbon in the case of hydrocarbon polymers. The redeposit occurs generally adjacent to the ablation area, but the exact redeposition zone depends on energy density and its distribution over the ablation area. In fact, the symmetry of the redeposition pattern is an excellent test of the symmetry of energy density in the ablation zone itself. Higher energy density spreads the deposit over a wider area. Fig 1a. shows areas ablated in PI with 100shots @ 1.5J/cm², the associated redeposition, plus typical exfoliation of parts on the deposit during subsequent laser machining of adjacent zones.

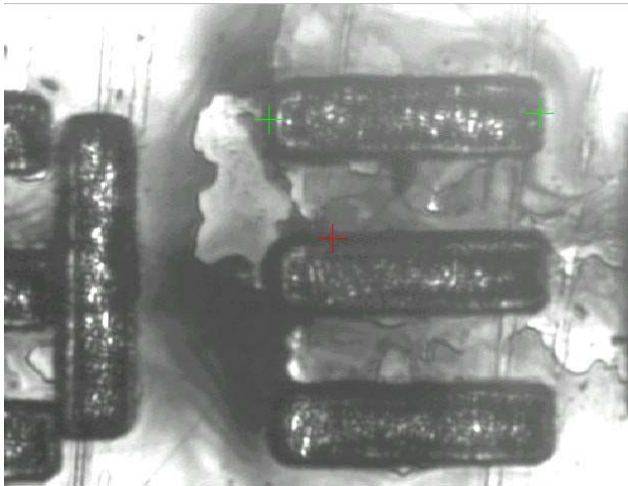


Fig1a -PI ablation in air

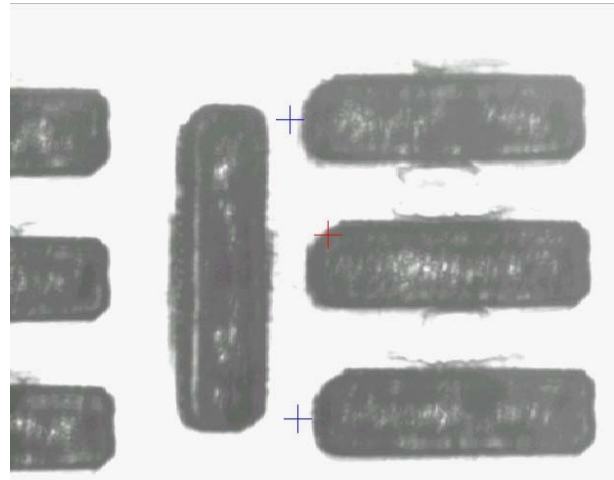


Fig1b - PI ablation in He atmosphere

For obvious reasons, airflow near the ablation zone (as for e.g. with a gas jet or suction) can have very limited effect unless the airstream velocity approaches supersonic speed. Various alternative methods of eliminating the deposit have been used, including electrically charged wires and sacrificial films. However the most direct and obvious method is to avoid momentum exchange with the surrounding atmosphere by eliminating the atmosphere. Vacuum ablation is essentially deposit free, but somewhat impractical.

Using a lighter gas atmosphere is the next best option, and He the only practical safe solution, providing reasonably effective debris control – Fig.1b.

However, the refractive index of He is significantly different from air, so that careful control of He flow is required to avoid degradation of the UV optical image by infiltration of He/air mixture into the beam path. A typical coaxial gas nozzle construction is shown in Fig.2.. The inner tube carries a flow of He sufficient to prevent thermalized ablation products reaching the optical surface of process lens or protective window. Reproducible flow is obtained using flowmeter and ON/OFF stopcock in the He line. An outer coaxial tube is used to flush away the used He including ablation products, some of which may be injurious to health; therefore fumes must be fed to factory exhaust or gas scrubber via suitable air blower used as extractor. Flush throughput must necessarily exceed He flow rate, exact flow rates to optimize redeposit elimination for minimum gas flow can only be determined by experiment in any particular case. In general, for a large flat part the distance between He gas tube and part is somewhat greater than the distance between outer tube and part, though optimum distances of both depend on part shape.

A similar principle has been successfully applied to larger gas nozzles with ablation area exceeding 1cm².

In some cases the gas nozzle can be fixed directly to the process lens; in other cases an independent module with window is provided. Nozzles with independent mounts can also be equipped with pneumatic lift linked to process control.

Consult Optec for further details of nozzles and auxiliary gas handling equipment.

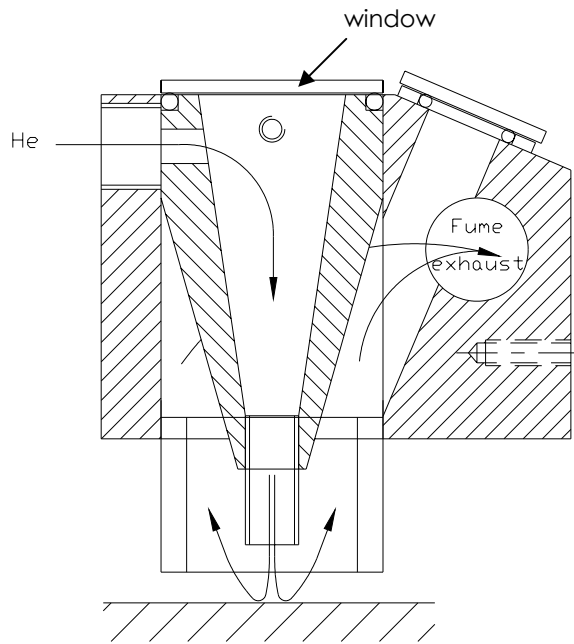


Fig2a LightDeck Gas Nozzle

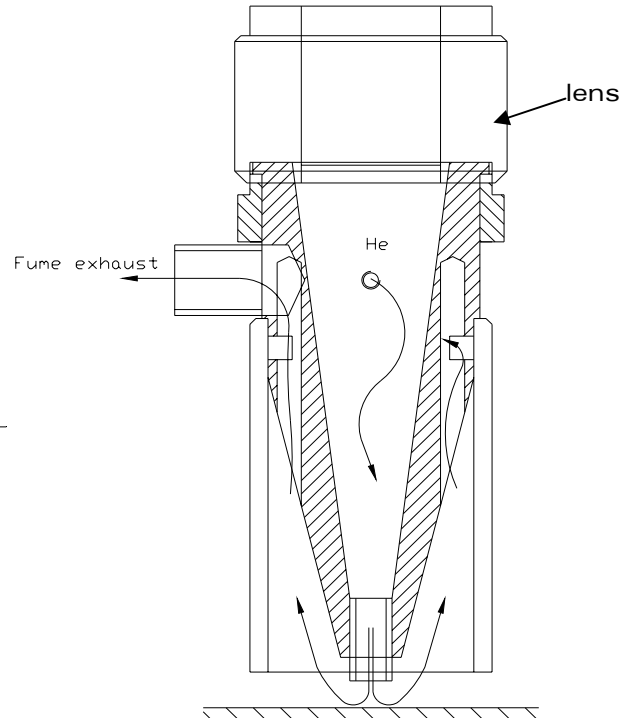
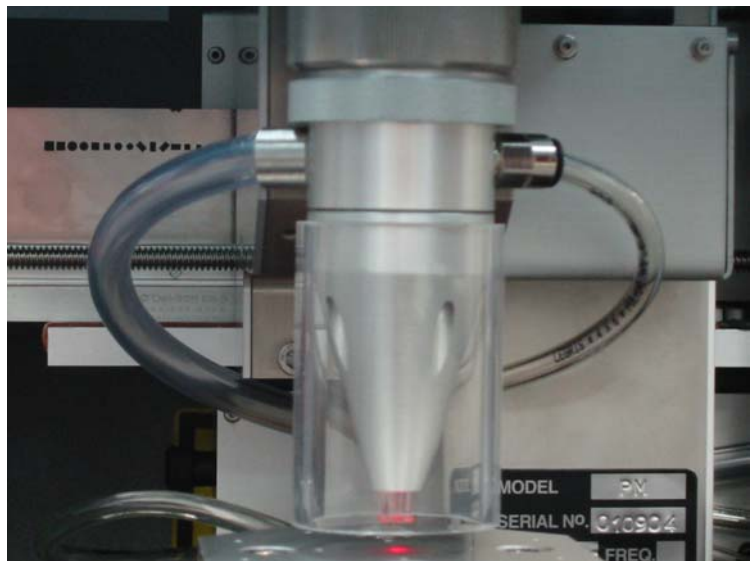


Fig2b ProMaster Gas nozzle

ProMaster Gas Nozzle



Fixing of LD type nozzle to LightDeck base with hydraulic lifting mechanism(MicroMaster)

