Reaction of laser plasma on Nd:YAG with a high optical mass.

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Abstract

Traditional material processing techniques such as material cutting, thin plate drilling, and surface processing are replaced by laser material processing (LMP). When a high-energy laser is projected onto a material, the temperature of the substance rapidly rises, changing its properties and causing the material on the surface to evaporate and peel off. In this study, we used a Quantel Brilliant neodymium-doped yttrium aluminium garnet (Nd:YAG) laser with a wavelength of 1064 nm, a pulse width of 5–6 ns, a beam diameter of 6 mm, and a 10 repetition rate (Hz) on the energy stability is within 5.60 percent, and an F-theta lens to obtain a focused laser beam with a diameter of 0.2 mm.

Keywords: Laser plasma, Optical mass.

Introduction

Drilling holes in a 3-mm thick optical-grade acrylic polymethyl methacrylate (PMMA) plate with high optical density and 7+ safe windows were accomplished using the devised technique. The material to be drilled was a PMMA plate, and the sample was laser-safe, flat-window, visible-light-transmitting (VLT). The laser beam must be focused on the F-theta lens's centre and aligned with the F-theta lens's distance from the linear stage. 300 mm was chosen as the working distance. Furthermore, in order to achieve the laser plasma effect, the diameter was regulated; that is, the working distance was fixed. First, the characteristics of the laser plasma were investigated, as well as the laser's capacity to penetrate optical-grade acrylic (PMMA) plate samples. The laser beam was aimed at different points on the acrylic (PMMA) plates by altering the lifting position of the vertical axis and varying the working distance of the acrylic (PMMA) plates. Because of the created cavity gap, the Nd: YAG pulsed laser can produce laser plasma that can expand the hole diameter by up to 50%. Various exit and entrance whole shapes can be achieved and used for a variety of purposes, including laser beam cutting [1].

Laser beam machining (LBM) has recently been used in cutting and drilling operations. The drill whole diameter has been reported to be affected by laser plasma in numerous investigations. Initially, laser plasma was used to clean materials and Raman spectroscopy was utilised to identify them. Plasma surface modification can dramatically increase the hydrophilicity of a surface and traditional old artefacts like the Bible's laser-clean sheepskin [2]. A study employed Raman spectroscopy to check the contents and crystals of jewels, as well as the legitimacy of the materials, in order to identify gems and diamonds.

Laser drilling is a thermal processing technique that involves drilling a hole in a material with a high-energy, focussed laser, causing the substance to melt and evaporate. The steam pressure generated during the procedure throws the material particles out of the drilling hole. Material deposition and removal, as well as changes in material characteristics, are all possible using a direct energy source (e.g., a laser). The advantages of using lasers as a thermal energy source for material processing are excellent depth and energy control. As a result, traditional material processing technologies have been superseded by laser material processing (LMP) [3]. A high-energy laser is focused on a material in LMP; as a result, the material's temperature rises fast, and the matter transitions from solid to liquid to gaseous phases, with its atoms blasted apart to form plasma, a pseudo-gaseous soup of subatomic particles. The increase of laser power leads to mass ablation rate from the target means more excited atoms and hence increasing in the height of the spectral line intensities. The increase in laser power will increase its absorption in the plasma resulting in more ablation as well as plasma emission [4].

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