

Laser microdrilling of an Al-Zn alloy

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More and more industries are employing laser drilling as a part of manufacturing process due to its flexibility, speed and accuracy. Because the laser drilling is a non-contact process, the wear is zero and zero is also the risk to get the tool broken inside the hole. If the laser beam is an advantageous tool for drilling, it is insurmountable for microdrilling, i.e. below 1 mm hole diameter. Under these dimensions laser is a direct competitor to electron beam machining, but without the need of high-vacuum and X-ray shielding. Applications of laser in the aerospace industry include the manufacturing of cooling channels in turbine blades and the drilling of fine arrays of holes in aerofoil skins in order to reduce the fuel consumption in airplanes. The first application involves the drilling of numerous deep holes in coated turbine blades to allow higher engine operating temperatures [1]. The second application is particularly of commercial airliners and will be explained with more detail: When a solid surface moves through a fluid (such as the air), frictional forces drag along a thin layer of the fluid adjacent to the surface due to the viscosity of the fluid [2]. This boundary layer exists in one of two states: laminar, where the fluid elements remain in well-ordered nonintersecting layers (laminae) and turbulent, where the fluid elements totally mix. The frictional force between the fluid and the surface is much larger in turbulent boundary layer than in laminar because of moment losses associated to the mixing action. In the case of a transport airplane flying at subsonic speeds, for example, approximately one-half of the energy (fuel) required to maintain level flight in cruise results from the necessity to overcome the skin friction of the boundary layer. Besides the strategies to the passive control of boundary layer (reducing the flight speed, controlling the air pressure over the wings and tails, etc.), it exists an active laminar-flow control by suction thorough air-cooling and removal of a small amount of the boundary layer air through porous materials, multiple narrow surface slots or small perforations. For a large-scale wing millions to billions of holes are needed, thus electron beam or laser drilling are the only feasible machining techniques. Also the typical requirements for machining are that the perforated skin had hole diameters on the order of 0.05 mm and hole spacing of 0.025 mm [3], only obtainable with electron or laser beam. This work studies the microdrilling of an Al-Zn alloy using two types of pulsed lasers: Nd:YAG and CuHBr. It was verified that both laser were suitable for microdrilling, but Nd:YAG, giving more intensity per shot, is more efficient for deep holes (up to 1.2 mm, here). On the other hand, the CuHBr produces very small heated affect zone, small remelted layer and few debris and it is particularly efficient for shallow holes (up to 30 μm).

Keywords: Laser drilling, laser surface treatment, aluminum alloys.

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