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Optimization of Laser Beam Welding On Titanium Material

Aniket Manohar Jadhav
[1](*Department of Mechanical Engineering, VIVA Institute of Technology, India)*

Abstract : *The use of titanium materials in some sections of mass-produced automobiles and in the aerospace sector has increased recently. Titanium materials however, are distinguished by difficult surface roughness, high melting point, dimensional stability, good thermal expansion, and high oxygen reactivity, overshadowing traditional production methods. To this purpose, the need for more advanced methods for the development of low-cost titanium materials is pressing. For the manufacture of titanium materials, many joining methods have been considered over the years. However, due to its efficiency, high specific heat input, and efficiency, laser beam welding offers an effective alternative for titanium welding. To present, the strength of the laser-welded titanium materials can be close to the original material under optimum operating conditions; some processing issues, such as lower elongation and shock resistance combined with lower fatigue properties, are still present. The laser beam welding on titanium materials is checked in this research work. There are also various types of parameters tested, such as nozzle size, focal length, pulse frequency and pulse duration. Experiment design is applied using the Taguchi method design method. The research will be carried out after the design of the experiment using the Taguchi Process, and the optimum result will be chosen.*

Keywords –*Laser beam welding, Titanium Material, Taguchi Method*

I. INTRODUCTION

Laser beam welding is a method of welding used to join metal or thermoplastic parts using a laser. [1] A concentrated heat source is provided by the beam, allowing for wide, intense welds and high welding speeds. The method is also used in high-volume automation applications, such as in the automotive sector. It is based on a welding keyhole or absorption method.[2] Laser beam welding has a high power density, like electron-beam welding, resulting in limited heat-affected areas and high heating and cooling speeds The laser beam size ranges from 0.2 mm to 13 mm, while smaller sizes are used for welding only.[1] The depth of penetration is proportional to the amount of power delivered, but is also dependent on the location of the focal point: when the focal point is just below the work piece's surface, penetration is significantly enhanced. Based on the application, a continuous or continuous wave laser beam can be used.

[2] LBW is a flexible tool that can weld carbon steels, Aluminum steels, stainless steel, aluminum and titanium. Deformation is a concern when welding high-carbon steels due to high cooling rates. The efficiency of welding is high, close to that of electron beam welding. [1] The welding speed is dependent on the amount of power delivered, but also depends on the work pieces' form and thickness. Gas lasers are specifically suitable for large size applications due to their high power capacity. In the automotive industry, LBW is especially dominant.

[2] Laser-hybrid welding, a derivative of LBW, combines the LBW laser with an arc welding process such as gas metal arc welding. This combination enables greater versatility in placement, since gas metallic arc welding supplies molten metal to fill the joint, and improves the welding speed beyond what is usually possible with gas metallic arc welding due to the use of a laser.[1] The efficiency of welding appears to be better, as the risk for undercutting is minimized.

1. Equipment

1.1 Automation and CAM

Although laser beam welding can be performed by hand, most systems are programmed and use a computer-aided production system based on computer-aided designs. In order to shape a finished component, laser welding may also be combined with milling. The RepRap project, which traditionally focused on the manufacture of fused filaments, recently extended to create open source laser welding systems. These systems have been thoroughly defined and can be used in a wide variety of applications while reducing the cost of traditional production.

1.2 Lasers

Solid-state lasers and gas lasers are the two kinds of lasers widely used. The first type uses one of several solid media, including synthetic ruby, glass neodymium, and the most common type, yttrium aluminum garnet neodymium. As a source, gas lasers use gas mixtures such as helium, nitrogen, and carbon dioxide. However, regardless of type, when the medium is excited, it emits photons and forms the beam of the laser.

1.3 Laser Beam Delivery

It is possible to group modern laser beam welding machines into two types: The laser output is shifted to match the seam in the conventional type. With a robot, this is normally done. Remote laser beam welding is used in many modern applications. In this process, with the assistance of a laser scanner, the laser beam is pushed along the seam, so that the robotic arm no longer needs to follow the seam. The benefits of remote laser welding are the higher speed and the higher welding process accuracy. Pulsed-laser welding has benefits over laser welding with a continuous wave. Some of these benefits include lower porosity and less spatters. Thermal analysis of the phase of pulsed-laser welding will help predict welding parameters such as fusion depth, cooling rates and residual stresses. Because of the complexity of the pulsed laser operation, a technique requiring a development period must be employed.

II. METHODOLOGY

[1] The welding machine is initially set up at the desired location (between the two metal parts to be joined). A high voltage power supply is applied to the laser machine for a later set-up to perform an operation. The lens is used to focus the laser into the region where welding is required. During the welding process, CAM is used to control the speed of the laser and the work - piece plate. [2] The flash lamp of the system begins and it emits light photons. Atoms of ruby crystals absorb the energy of light photons and electrons are excited to their higher levels of energy. They emit a photon of light as they return to their low energy state or ground state. This light photon activates the atom's electrons again and creates two photons. This process continues and we get a centred laser beam that is used to weld several parts together at the desired spot. [1] The method of laser deposition is also known as laser cladding or direct metal deposition. Welding requires the use of a filler material in order to create a metallurgical bond, with the surfaces of the filler material and the base material melting. Wire or metal powders are typical filler materials. Depending on the application, this process can be either automatic or manual.[2] Laser deposit welding can be used not only to join but also to fix weld surface defects, to form weld beads to create mesh-shaped parts, and to process metal surfaces.

FIGURES AND TABLES

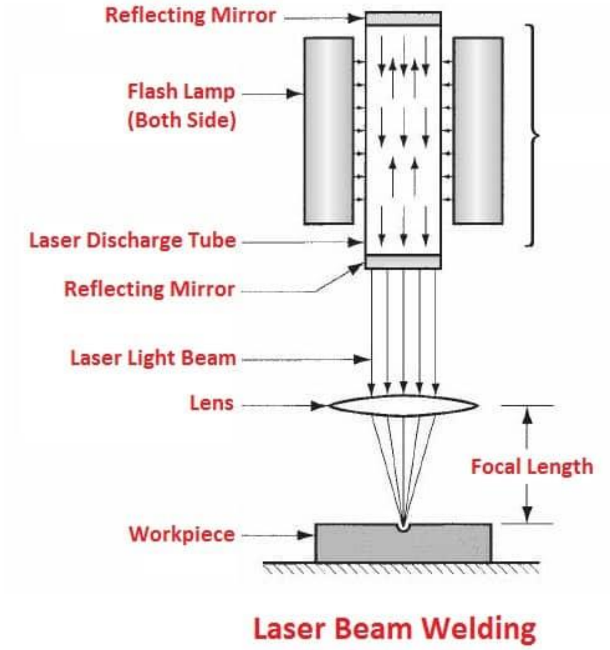

Fig. Laser Beam Welding

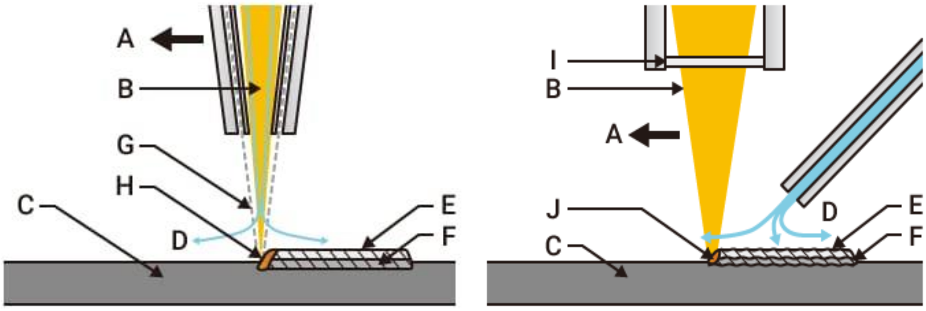

Fig. laser beam welding by filler material

A: Welding direction B: Laser beam C: Base materials D: Shielding gas E: Deposited metal F: Welded materials G: Metal powder H: Weld pool I: Protective eyewear J: Filler wire

III. CONCLUSION

[1] Improving the efficiency of laser beam welding can be accomplished by increasing absorption, which is the laser energy absorbed by keyhole walls. In workshop conditions, there are three simple ways to improve absorption: by changing the work piece by surface preparation; by lowering the pressure in the welding zone; and by modifying the preheating process. [2] Laser beam welding at high power levels has a major dependency on the edge surface roughness for thick section absorption. It is recommended to use manufacturing methods that manufacture edge surfaces with a pre-determined degree of roughness. A substantial increase in penetration depth is achieved by reducing the ambient pressure in the welding field.

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