Laser Assisted Cladding – A Review

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Abstract

Laser Assisted Cladding (LAC) is one of the most extensively used thermal energy dependent non-contact type advance cladding technology having capability of obtaining a treated surface on wide range of surfaces on materials precisely and accurately. A Laser beam focused on to the clad material generates enormous amount of thermal energy, as electrons hit the surface with high kinetic energy resulting in conversion of this kinetic energy into heat energy. This leads to localized melting of clad material with parent material or substrate enabling a proper mixing of both. So precisely, a different layer of material is deposited over a different substrate material. Laser cladding technique is very important in industries so that a very superior metal coating can be obtained on an inferior metal, resulting in improved mechanical properties. This process can be obtained in two ways, depending upon timing of placement of powder in the zone. The driving force for the research on the laser cladding is the advantage that laser beam possess, i.e. its high accuracy and low HAZ area resulting in precise cladding process. Even after many years of the evolution of laser beam & laser cladding technology, still a lot of betterment & exercise is to be yet done by the researchers. Lot of researchers have tried to focus on the various process parameters, types of lasers thereby increasing the efficiency & applicability of different cladding materials on different materials. This paper deals with the review of the research explored on the laser cladding technology in recent years by various researchers.

Key words: *Laser Assisted Cladding, HAZ, Clad Material, Laser beam.*

I. INTRODUCTION

To improve the mechanical properties on the surface of metallic mechanical components, like to protect the surface from wear and tear from surface corrosion, many heat application based surface treatments are available; for eg. Flame spraying, Plasma spraying and arc welding procedures [1]. A suitable technique is to be chosen, that has a good bonding characteristic of the applied layer of metal on the parent metal, the heat applied in this process doesn't affect the overall mechanism and the overall mixing of the coat-layer to the parent metal layer is properly achieved properly. These above features can be achieved through by a process "Laser Assisted Cladding" (LAC).

So a Laser Assisted Cladding can be explained as a techniques which uses laser to melt the metal and fuses this semiliquid on to the surface of the substrate over which the metal coating is required. This paper provides a review on the laser assisted machining and various research activities continued in LAC process.

II. LASER ASSISTED CLADDING (LAC)

This segment focuses on the basic fundamentals of the LCT process and its variants.

A. Laser Source

Laser (Light Amplification by Stimulated Emission of Radiation) is a coherent and amplified beam of high speed electrons. The significant element to obtain a laser is amplification of light and focusing the stimulated emission of radiation. [1] A laser primarily has three constituents, laser medium, source for exiting the laser medium and optical feedback. [1]Laser medium may be a solid (Nd:YAG or Neodymium doped Yttrium Aluminum Garnet) or Liquid or gas [2].

Unlike of ordinary light, laser light has high intensity as the photons present would be of same frequency, wave length and will be in phase. So Laser light has unidirectional property unlike a ordinary light. So among different types of laser available Nd:YAG and CO_2 laser are widely used for obtaining good quality and high average beam power laser.

B. Principle of Laser cladding

Laser cladding is a method of treating surface using lasers. The beneficial side of the laser assisted cladding is change in composition of material on the surface because of moving thermal source on the workpiece surface [1]. The process is shown in the Figure 1. Laser cladding is melting process in which the laser beam is used to fuse an alloy addition on to a substrate.

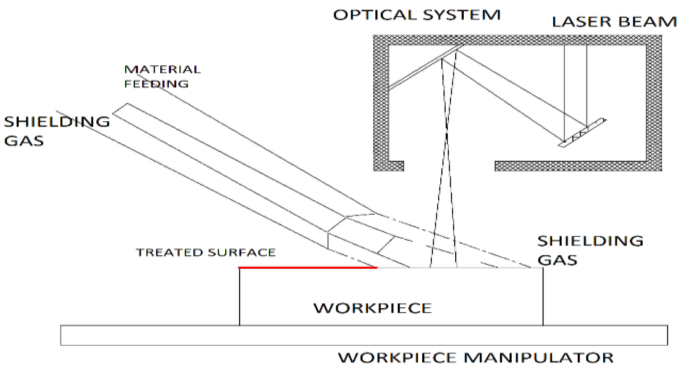


Figure 1 laser beam is focused on a target area on workpiece [2]

C. Variants of Laser cladding process

The alloy may be introduced into the beam-material interaction zone in various ways, either during or prior to the processing as shown in the figure 2(a) & (b). Figure 2 (a) shows the clad powder is delivered or blown into the zone of workpiece and laser interacts [2]. Heat produced by the laser beam is utilized to convert the phase of clad material and substrate material. A similar case can be observed in Figure 2(b), in which a clad material is preplace on the substrate material

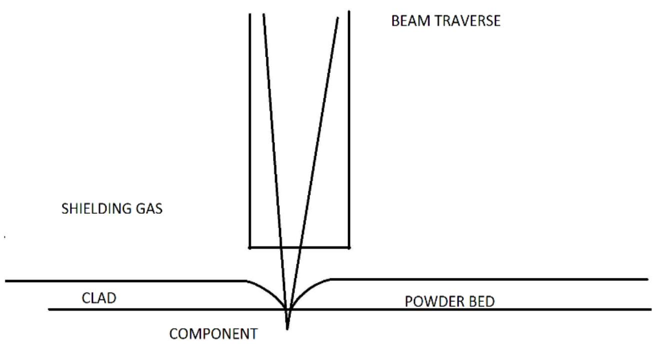
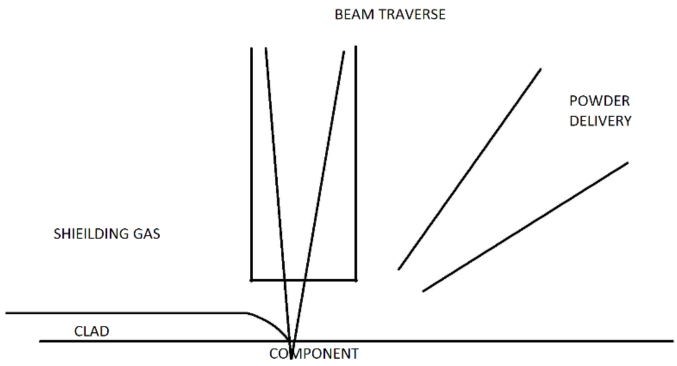


Fig 2 (a)



Figures 2 (a) & (b) shooing different methods of laser cladding techniques [2]

In contrast to other laser surface treatments, in LCT a thin substrate layer is melted along with the clad material resulting in a proper homogenized mixturing and solidification.

The Clad material or the alloy mixture can be pre-deposited (placing Clad in the zone prior to the process) or co-deposited (inducing the powder into the zone during process), and amount can also be controlled depending upon the ratio of mixture to be attained [3].

The metallurgical bond so formed between clad and the substrate facilitates rapid transfer of heat or energy into the substrate, which acts as effective heat sink [3]. A heat affected zone (HAZ) is formed beneath the clad material. Thermal gradients present in the clad and substrate induce residual stress.

III. LASER ASSISTED CLADDING - APPLICATIONS

Laser assisted cladding has many applications in the field of automobile, aviation sector, electronic industry, civil industries and household applications. It has a prominent application in machine tool industries. Laser cladding process is used to refurbish the worn out parts and improve the life of the component. Cobalt based stellite clad materials are very popular in rebuild the worn turbine blades [4].

The cobalt base alloy is for hard-facing the material and avoiding the crack sensitive alloyed area being formed [4]. Many industries of aviation sector such as General electric, Honeywell have refurbished the worn-out and damaged aircraft engines [5].

IV. MAJOR AREAS IN LASER ASSISTED CLADDING

Laser cladding method prevents stress corrosion cracking occurrence for small diameter pipes and it also improves the chemical composition inner surface [6]. Induction heater is introduction results in uniform mixing of the molten metal pool. Numerical analysis predict the reduction in stress concentration at the interface of clad and substrate [7]. Also the non-wetting behavior of the carbide is enhanced as a induction heater is introduced resulting in improved carbide transfer [7].

Formation of cracks in single crystal turbine blades used in aviation sector can also be processed using laser cladding. Cracks observed at the tip of the blade can be solved by using multi-layer cladding. The grain growth is controlled by a thermal gradient which is created using induction heater [8] [9].

V. CONCLUSION

The work focused in this paper is on the review and recent developments in laser cladding.

- Laser Cladding is a very powerful technique to improve the applicability of a inferior material by coating with a superior metal.
- Laser assisted cladding can be used on wide range of materials.
- Laser assisted cladding is influenced by many process parameters that evaluate the efficiency, economy and quality of the coating developed.

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