Proceeding of NCRIET-2015 & Indian J.Sci.Res. 12(1):217-220, 2015 ISSN: 0976-2876 (Print)
ISSN: 2250-0138 (Online)

STUDIES ON CLADDING TECHNIQUE OF DISSIMILAR MATERIALS USING FRICTION STIR WELDING PROCESS

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ABSTRACT

Cladding is the bonding of dissimilar metals Cladding is the bonding together of dissimilar metals. It is different from fusion welding or gluing as a method to fasten the metals together. Cladding is often achieved by extruding two metals through a die as well as pressing or rolling sheets together under high pressure. Nowadays, the cladding techniques are being utilized in a wide range of industries such as food processing, fertilizer, chemical, petrochemical, automotive, nuclear and power plant. Cladding is done to enhance material properties such as wear, electrical or corrosion at some area of the part or component.

KEYWORDS: Cladding, FSW

Friction stir welding (FSW) is a solid state welding process used for welding similar and dissimilar materials. The process is widely used because it applications and it produces sound welds compare to other welding processes. Friction welding is generally used for aluminum alloys, it has now extended its reach to other variety of materials. Frition stir welding based technologies have been in the edge for scientific development and different efforts have been carried out to improve the process and to apply it to the materials and joint. Since for some of the dissimilar materials it's very difficult to weld with conventional welding processes. Examples include achieving a sound steel/aluminum joint by using fusion welding processes. The development of friction stir welding of dissimilar materials will provide a good insight on their possible industrial applications and therefore enhancing industrial development. Friction stir welding could be used in various industries including, automobile, ship building, aerospace, electrical and construction. Friction welding is well known for its ability to weld aluminum to many metals.

CLADDING

Laser Cladding: It is the bonding of dissimilar metals with a purpose of improving surface properties of metals.The use of cladding protects the metallic structure from corrosion,in cladding process the materials are bonded electrically, mechanically,or through some high pressure and temperature process. The majority of clad products made today uses carbon steel as the substrate and aluminum, nickel, nickel alloys, copper, copper alloys and stainless steel as the clad materials to be bonded. Typically, the purpose of the clad is to protect the underlying steel substrate from the environment it resides in. Cladded steel plate, sheet, pipe, and other tubular products are often used in highly corrosive or stressful environments where other coating methods cannot prevail. Cladded metal can be produced by many methods including explosion bonding, roll bonding, diffusion bonding, mechanical bonding, forging,

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laser, welding, friction welding or co-axial extrusion. The resultant clad products have either a mechanical or metallurgical bond to their substrate. Increase in thermal and kinetic energy increases chances of metallurgical bonding. The strength of the bond as well as the strength retention of the backing steel substrate determines the usefulness of the layered composites in subsequent metal forming processes or end user environments.

TYPES OF WEAR

Abrasive Wear occurs when material is removed from one surface by another harder material, leaving hard particles of debris between the two surfaces. It can also be called as scratching, gouging or scoring depending on the severity of wear.

Erosive Wear occurs due to solid particles, or small drops of liquid or gas often cause what is known as erosion of materials and components. Solid particle impact erosion has been receiving increasing attention especially in the aerospace industry.

Adhesive Wear is often called galling or scuffing, where interfacial adhesive junctions lock together as two surfaces slide across each other under pressure. As normal pressure is applied, local pressure at the asperities become extremely high. Often the yield stress is exceeded, and the asperities deform plastically until the real area of contact has increased sufficiently to support the applied load, in the absence of lubricants, asperities cold-weld together or else junction shear and form new junctions. This wear mechanism not only destroys the sliding surfaces, but the generation of wear particles which cause cavitation and can lead to the failure of the component.

Surface Fatigue when mechanical machinery move in periodical motion, stresses to the metal surfaces occur, often leading to the fatigue of a material. All repeating stresses in a rolling or sliding contact can give rise to fatigue failure. These effects are mainly based on the action of stresses in or below the surfaces, without the need of direct physical contact of the surfaces under consideration. When two surfaces slide across each other, the maximum shear stress lies some distance below the surface, causing microcracks, which lead to the failure of the component.

Corrosive Wear, in corrosive wear the dynamic interaction between the environment and mating surfaces play a significant role, whereas the wear due to abrasion, adhesion and fatigue can be explained in terms of stress interactions and deformation properties of the mating surfaces. In corrosive wear firstly the connecting surfaces react with the environment and reaction products are formed on the surfaces asperities.

THE ECONOMIC EFFECTS OF CORROSION AND WEAR

The progressive deterioration, due to corrosion and wear, of metallic surfaces in use in major industrial plants ultimately leads to loss of plant efficiency and at worst a shut down. Corrosion and wear damage to materials, both directly and indirectly. However this could be avoided by proper corrosion prevention method and wear control measures.

METHODS TO CONTROL CORROSION AND WEAR

Application of corrosion-resistant coatings is one of the most widely used means of protecting metals, there are as wide variety of coatings to choose from, and proper selection is based on the component size and accessibility, there corrosive environment, the anticipated temperatures, component distortion, the coating thickness attainable, cost and the depending on the applications. There are wide varieties of coatings methods like weld overlay, friction surfacing, thermal spraying, carburizing, carbonitriding, nitrocarburizing, nitriding, mechanical plating, electroless plating and cladding have been developed to improve material surface properties for outdoor exposure, marine atmosphere, water immersion, chemical fumes, extreme sun light, high humidity, and high temperature applications.

RELATED STUDIES ON CLADDING AND FRICTION STIR WELDING

R.S.Mishra and Z.Y. Ma in there review paper explained that Friction stir welding is a relatively new solid state joining process. This

joining technique is energy efficient, environment friendly, and versatile. In particularly, it can be used to join high strength aerospace aluminum alloys and other metallic alloys that are difficult to weld by conventional fusion welding [R.S.Mishra,2005].

Arnoud van der Stelt in his thesis explained Friction surface cladding process , in this explorative study FSC showed that clad layers can be produced by using FSC ,which consist of a mixture of clad material and substrate material. FSC process allows the deposition of clad material without deforming the substrate on a large scale in order to form non-intermixed layers. During this study electrochemical measurements showed that non-intermixed clad layer enhances the corrosion resistance properties. This study also shown that the tool design also major influence on the generation of quality clad layer [Available at 2].

Stelt, A.A vander, Bor,T.C Geijselaers Akkerman, R and Boogard A..Vanden they explained about solid state cladding process, based on the Friction Stir Welding friction surface cladding technology enables the deposition of a solid-state coating using filler material on a substrate with good metallurgical bonding. A relatively soft AA1050 filler material is deposited on the top of the substrate [Stelt,2013]

Mukuna P.Mubiayi, member IAENG and Esther T.Akinlabi, member IAENG carried out a review on Friction Stir Welding of dissimilar materials between aluminium alloys and copper. In this review FSW process is an eco-friendly solid state joining technique compared to the conventional welding techniques. The joining of aluminium to copper using FSW has been reviewed to open a research window to researchers in order to expand the technique to other aluminium and copper alloys with the aim of achieving optimised parameters thereby leading to the commercialization of joints between these materials. Research on friction stir welding between aluminium and copper has not yet been thoroughly researched; much of the work has been focused on welds characterizations and study of the material flow. There is however, a strong need in developing the industrial applications of FSW between aluminium and copper in the manufacturing sector for the enhancement of the industries. Thus, the use of the FSW technique to join aluminium and copper alloys and material shapes is of importance in the development of their industrial applications [Mukuna P,2003].

ADVANTAGES OF CLADDING

1.Cladding is one of the best method to improve the life of the component.

2.Cladding is a cost saving technique reduces the cost of replacement.

3.Cladding provides a long-life and high reliability corrosion resistance to harsh environment applications.

4.Cladding is very economical way to provide excellent corrosion resistance for steel structures.

SOME INDUSTRIAL APPLICATIONS OF CLADDING

1. The weld cladding technique is regularly applied in various types of industries, either for the purpose of maintenance or manufacturing new component.

2. Cladding technique is used to reduce wear of grey cast iron mill rollers in the sugar cane industry. Reducing the wear of the rollers helps in the use of greater extraction loads and better movement of the crushed cane through rollers.

3. Cladding is also used for repair welding on heat-resistant cast steels which are widely used for the manufacturing of components parts for the petrochemicals industry.

4. Cladding techniques are being utilized in a wide range of industries such as food processing, fertilizer, chemical, petrochemical, automotive, ship building, nuclear and power plant.

5. Cladding used for surfacing the internal surfaces of pressure vessels and large diameter pipe and in the reclamation of steel mill rolls.

CONCLUSIONS

Friction stir welding is an eco-friendly solid state joining process compare to other types of welding techniques. A literature review has been carried out on friction stir welding and cladding technique. It is found that variety of surface

modification techniques are available and have their own advantages, disadvantages and applications.

Friction stir welding having edge over other types of welding process because of its advantages like; Excellent bonding improved coating material properties, no melting of materials. Negligible dilution, Small localized HAZ (heat affected zone), no cracking in the HAZ, Automatic & highly repeatable process, can deposit a wide variety of dissimilar materials with a good metallurgical bond.

Friction stir welding equipment can be used for cladding process, variety of materials can be cladded by friction stir surfacing process. However there is a strong need of developing and studying the process parameters of FSW for cladding process in order to fill the gaps with new research approaches and techniques; that can be used for improving the surface properties of the material and increasing their corrosion resistance in the underwater applications.

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