

LASER REMANUFACTURING TECHNOLOGY AND ITS APPLICATION

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Abstract

The laser remanufacturing technology was one important technique to enhance performance for momentous mechanical equipments. This paper introduced laser system and characteristic of laser remanufacturing technology. The laser technology application field was also introduced. And this paper enumerated some typical example of laser remanufacturing mechanical equipments. The author pointed out that the development of laser remanufacturing technology not only has extensive market foreground, but also has momentous economic and social benefits.

Keywords: laser remanufacturing, laser cladding, technology, applications

1 Introduction

Since the 20th century, laser was another important invention after nuclear, computer, and semiconductor. Laser technologies have developed at very fast speed since it's come out. Because there are some special features such as high brightness, good directivity, good homochromy, high meddle and special characteristics of spatial distribution, duration control, polarization. So the laser has become an incomparable instrument of manufacture and material processing. The development of laser technology not only refreshed antiquated photology and optical technology, but also bring us a new effective technique.

In our country, much important engineering equipments often stop production due to impairment and scarcity of duplicate parts. Making new part to repair provisionally was expensive and time-pressure. So we developed new, fast, efficient, accurate technology to repair failure equipment. Not only have extensive market foreground, but also have momentous economic and social benefits

Laser remanufacturing technology is a new advanced repair technology. It composed advanced laser cladding technology, cladding material technique, and other correlated technique. Using this technique not only can recover spoiled parts' physical dimension, but also make parts' service performance equal to or even exceed new parts^[1].

2 Laser remanufacturing technology system

Laser remanufacturing technology contains equipment manufacturing engineering, material science and

technology, laser processing technique and so on. Fig.1 is its composition diagram.

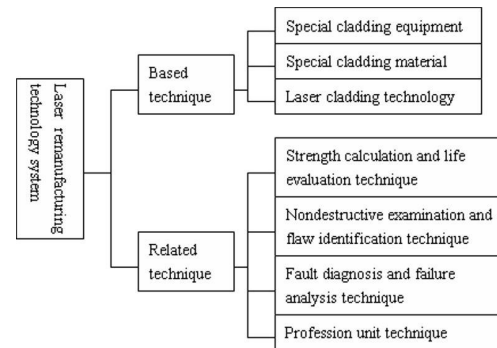


Fig.1: Laser remanufacturing technology system.

The key technique of laser remanufacturing technology is laser cladding technology. The laser cladding technology use high energy density laser fusing cladding material and basal body together, and generated laser cladding layer^[2]. It is a new surface modification technique. Compared with traditional spray welding or build-up welding, the laser cladding technology has following advantages:

(1) Because of its high energy density, the laser can clad metal material at low power. The heat-affected zone and the distortion of repaired part is small, so laser remanufacturing technology can suitable strengthening or repair some high degree of accuracy parts, such as strengthening the surface of planishing roll.

(2)The laser cladding layer's rate of dilution is small. Its component and performance depend on cladding material. Various excellent performance laser cladding material bring laser cladding technology more advantages, and it can repair some failure part that conventional build-up welding technology can't do well, such as turbine blades, roller backbone, electric motor shaft.

(3)there are some advantage of laser cladding layer such as compact structure, little flaw, metallurgical bonding with base body, high bond strength. The laser cladding technology can be used to repair or surface peening heavy-load parts, such as large roller, large gear, and large crankshaft and so on.

(4)The size and position of laser cladding layer can be controlled exactly. we can heat treating deep hole, internal hole, fillister, and blind hole using special laser deliver system. the cladding layer's breadth can reach 20 ~30 mm, its height can exceed 3 mm using special

broadband scanning system. This technology can do large acreage laser cladding and three-dimensional formation throughout overlapping and stacking. The cladding laser system usually was 1~10kW CO₂ laser or 0.5~2kW Nd:YAG laser.

The key of this technology successfully application is that the design and choose laser cladding special alloy powder. The difference between coefficient of thermal expansion of cladding layer and substrate was the first consideration. The second was the melting point of cladding material. We also must consider bond strength, high-temperature behavior and anti-crack performance of cladding layer. The Co-Cr based, Ni-Cr based and Fe-Cr based alloy powder often were selected as cladding material in practical application. Sometimes a certain amount ceramic material was added in powder, such as WC、TiC、Al₂O₃、VC、BN、ZrO₂、SiC、B₄C and so on, which formed compact and super hard metal ceramic cladding layer.

The laser cladding technology main parameters consisted of laser power, powders deliver amount, spot size, laser scan speed and overlap width. On different conditions we must choose different cladding parameters. The strength calculation and life evaluation technique, nondestructive examination and flaw identification technique, fault diagnosis and failure analysis technique and profession unit technique were considered as laser cladding technology remanufactured key equipment. Fig.2 shows concrete technological process diagram.

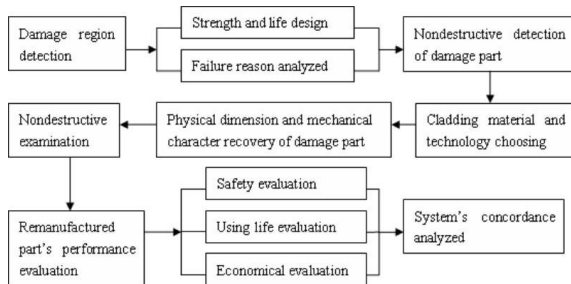


Fig.2: Concrete technological process diagram of laser remanufacturing mechanical equipment.

3 Characteristics of laser remanufacturing technology

Laser remanufacturing technology used damaged or old and discarded parts as remanufacturing semi-finished product, which mainly utilized high and new technology such as laser cladding technology to process batch repair. The remanufactured parts have a series of features as high-quality, highly active, energy saving, economy and environmental protection, which can equal even exceed original production's quality.

The significant advantage of laser remanufacturing technology is high performance cladding layer which prepared by laser cladding technology, which was endowed with excellent performances such as high-temperature, corrosion resistant, anti-abrasive, fatigue resistant and radiation resistant.

The cladding layer's thickness varied from tens microns to tens millimetres. Compared to bulk materials, it has thin and small area characteristic, but it ensured main

working function. Laser remanufacturing technology saved many processing energy and precious metal materials. Laser cladding was a green process technology with non-contact, pollution-free, low noise and saving materials^[3]. All these advantages make this technology become our country's durable development strategy important technique.

4 Application of laser remanufacturing technology

Laser remanufacturing technology is a new advanced technique in the remanufacturing field, which has made a great development. There are many applications in the industry, such as repairing turbine laminas by U.K. P.R. Aero Engine Company and repairing vessel screw propellers by U.S. Navy Lab^[4]. In America and Japan, there are also many usages for repairing of auto engine cylinders, pistons and so forth. In our country, laser remanufacturing has also made a great progress in recent years. Lots of specialization laser remanufacturing companies just appeared continuously. One of these is ShengYang DALU Laser Technique Limited Company, which is a main leading company. There are many successful laser remanufacturing application examples such as the smoking turbines, fans and electric engines in the petrochemical industry, steamers and electric engines in the electric industry, the heat-roll bending tandem mills, bars, high speed wire rod finishing blocks in the metallurgy industry, lorry wheels, locomotive bent axles in the railway industry, hot junction parts of aircraft engines, and hot junction parts of large-sized ship craft explosive motors and so forth.

4.1 The smoking turbine

The smoking turbine is an important energy recovery equipment of catalytic cracking units in the petrochemical industry. The machine gets faults frequently because of working in the high temperature, powder and corrosion environments, and impact on the productions. However, laser remanufacturing is an important method for repairing the smoking turbine. Fig.3 and Fig.4 are the conditions of atmosphere bearing location before and after laser remanufacturing. In application, all of bearing location rotor of smoking turbines, pushing plate, stationary blades, stationary rings, turntables, atmosphere planes and cone diversions has been mended with laser remanufacturing.



Fig.3: Conditions of atmosphere bearing location before laser remanufacturing.

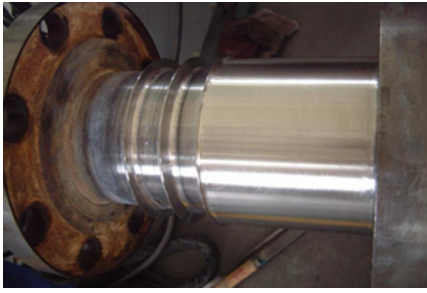


Fig.4: The conditions of atmosphere bearing location after laser remanufacturing.

According to the statistic, there are about 120 smoking turbines being used in our country. The different kinds of damages often occur as the bad working condition. From 1999 to 2007, only ShengYang DALU Laser Technique Limited Company just remanufactured more than 300 smoking turbines, whose owners are China LanZhou Steel, China West Airways, England Soland and Germany GHH.

4.2 Steamer turbine

The steamer turbine is the core equipment in fuel electric plant, the foundation of electric industry, and exhibiting one country's mechanical manufacture level. Because of the special working condition, a large amount of parts get damaged every year. Therefore, it's not only save lots of financing and raw materials but also relaxed the serious situation of supplying steamer by using laser remanufacturing to resume and promote properties such as principal axis bearing location(the locale mobile laser remanufacturing), moving blades, steam seal gears, pushing plate, muzzles, clapboards, shrcud rings, cylinder bodies(see fig.5) and so on.



Fig.5: Field remanufacturing cylinder body of steamer turbine.

4.3 The internal combustion turbine

The internal combustion turbine is a kind of turning power machine which is constituted of tail-wagging impellers, and transforms the heat energy produced by burning fuels into the output machine energy. Usually, this machine is used in electric power, petrochemical, metallurgy industry and so forth. The modern internal combustion turbine is constituted of compressors, fireboxes and turbines. Compressors and turbines are

tail-wagging impeller machines, and a key part using for the conversion between air current energy and machine energy. However, it often damages because of working under the high temperature 1300□.

On Mar 2007, Tornado type double-axis floor internal combustion turbine purchased from France ALSTOM Company by ChuanHua stock limited company appears large malfunctions and affects the production. Through checking the problem, they finds that gaps and knock traces appeared in lamina eject air side of first and second grade moving blades, blade coronals drop, blades backs and aerating cooling holes of blades ablate, some blades have cracks, and a lot of first and second grade muzzles laminas have ablating gap cracks even though it can't work. ShengYang DALU Company mends them using laser remanufacturing with only costing 1.4 million RMB which isn't up to ten percent of new machines. Fig.6 and fig.7 are the state of the first grade lamina before and after being repaired.

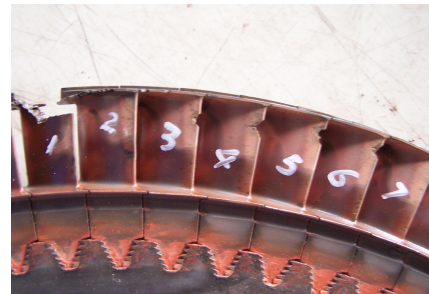


Fig.6: The damage state of the first grade lamina.



Fig.7: The first grade lamina after laser remanufacturing.

4.4 The lorry wheel

Nowadays, there are 2.8 million lorry wheels existed spoke holes cracks. They will be abandoned because of the huge safety hidden troubles and no others treatment methods. If they change new wheels, nearly 1 million tons wheels would be refined as wastes, while 1.4million tons steel, huge manpower and equipments, hundred of financing are needed. Besides, according to our country's wheels producing ability, there will be a big replacing cycle. Therefore, it can't meet the normal safety course after increasing the railway speeds.

ShengYang DALU Laser Technique Limited Company remanufactured lorry wheels with spoke hole cracks(shown as fig.8 to fig.10) through using advanced laser cladding technique which past the technique examination organized by railway department transportation office in May 26th 2006. And the new remanufactured wheels work in May 2008. It has safety worked 70 thousand miles till Aug 20th 2008.

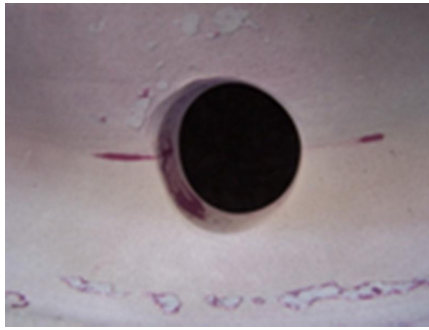


Fig.8: The cracks of lorry wheel's spoke hole.



Fig.9: Laser remanufacturing lorry wheel.

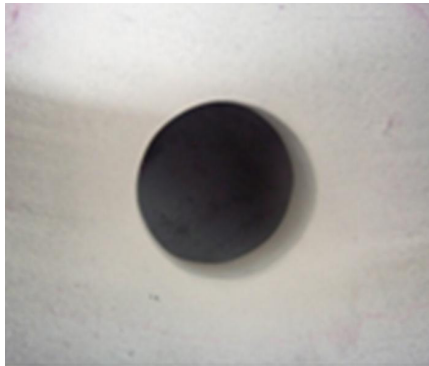


Fig.10: The remanufactured spoke hole.

4.5 The rolling mill framework

During the production of steel, the hot rolling machine is working under serious environments. Especially, rollers have a large impulse to the framework through bearing seats, while the cooling water atomizes immediately when contacting with glowing billets, and spraying the powders falling off the billet surfaces. As the influences of the rolling impulse, the corrosion of cooling water, and the oxidation powder, the corrosion abrasion exists in the inside rolling-mill housing of window surface, the substrate of rolling-mill housing, the outside roller surface and inside roller fixing holes. On Nov 2007, ShengYang DALU Laser Technique Limited Company worked continuously in 96 hours to remanufacture No.1 slab-line in BaoShan steel company, and had finished the anti-corrosion and wear-resisting treatment of rolling-mill housings in locale (as show fig. 11).



Fig.11: Field remanufacturing rolling mill framework.

5 The prospect of laser remanufacturing technology

On May 2008, the National Standard committee authorized that LiaoNing quality supervising office found "National standard laser repairing techniques committee". And ShengYang DALU Laser Technique Limited Company was the secretary-general department of this committee, which indicated a more standard, more professional development direction followed by laser remanufacturing technique.

On Dec 2007, "the mobile laser processing system based on whole solid laser lamp-house" was considered as "originating in native country, and reach the international advanced level" by experts. The successful development of this system has extended the laser remanufacturing technique application scope, and created conditions for laser remanufacturing big machines in locale.

The laser remanufacturing technology accorded with the national cycle economy and the continued development strategy. This new technique is supported greatly by our country. With the development of the foundational research, its application scopes will also be enlarged. Furthermore, there are several thousand billion RMB equipment assets in our country, and the loss caused by equipment stop production, discarded equipment is up to hundreds of billions RMB. Thus, there is a great application prospect for laser remanufacturing technology.

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