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Laser Padding Welding in Technology of Rebuilding Mechanical Components

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Abstract. This paper presents results of rebuilding mechanical components using laser technology. Laser technology, including padding welding, is an advanced method of regenerating exploited mechanical parts. Using metallic powder as a filler material and laser beam as a heat source, rebuilding and modification of reliability properties of surface can be done. The article presents results of rebuilding of connecting rod surface using laser technology.

Introduction

Wear of mechanical components working in motion when friction phenomena occur is inevitable [1]. Some components can be regenerated, and further, surface properties can be modified using padding welding technology. Rebuilding technology which uses laser beam as a heat source and metallic powders as an additional material is one of the fastest methods. The amount of heat absorbed in material is relatively small [2, 3]. A metallographic structure changes only into a narrow heat affected zone and stresses occurring in thermal processes are much lower than in other techniques. In some cases, a replacement of exploited parts might be very expensive and difficult, and the operating time of components could be assumed to be similar. During surface regeneration, wearability could be improved. Traditionally, additional materials have similar chemical composition as base materials, however, using metallic powder with different chemical composition properties of padding welding surface could be modified. Appliances metallic powders as additive material facilitates modifications.

Experiment

Laser padding welding experiments of a regenerating surface of connecting rod were carried out with an indigenously developed 6 kW TruFlow 6000 CO_2 laser working on a TruLaserCell 1005 station. The folded laser beam was focused using a 200 mm focal length parabolic mirror. The cladding process involved both scanning of the surface of the substrate with a 3 mm wide defocused laser beam and a simultaneous injection of CrNi powder (gradation of 45µm) into a molten pool on the surface of the substrate[4]. Overlapping tracks were first made on the flat surface.

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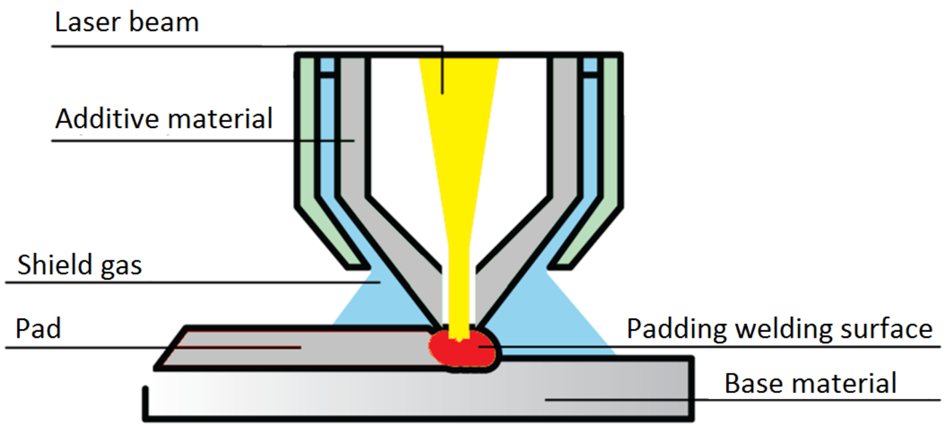

Fig 1. Laser padding welding process.

The chemical composition of the additional material was 65% of Nickel and 35% of Chromium. In order to study the effect of heat input in the component, laser padding welding was conducted at three different power levels to shown quantity of heat input during the laser process, while keeping other parameters constant[5]. The laser padding welding parameters are given in Table 1. Laser clad specimens were investigated by visual testing (VT) using a Hirox KH-8700 confocal digital optical microscopy, a JEOL JSM – 7100 F (SEM) scanning electron microscopy and microhardness measurement.

Table 1. Laser padding welding parameters.

Parameter:	Padding weld 1	Padding weld 2	Padding weld 3
Power	2.5 [kW]	3 [kW]	3.5 [kW]
Process velocity	1200[mm/min]	1200[mm/min]	1200[mm/min]
Shielded gas	Argon 15[l/min]	Argon 15[l/min]	Argon 15[l/min]
Carried gas	Helium	Helium	Helium

Testing results.

VT results, including padding welding profiles and macrostructure in cross section, were carried out. The results showed that a pad welded with the power of 3kW has good profile characteristics (Fig 2.) and less scatters than the other two samples. A pad made with those parameters was carried out for microscopic and hardness tests.

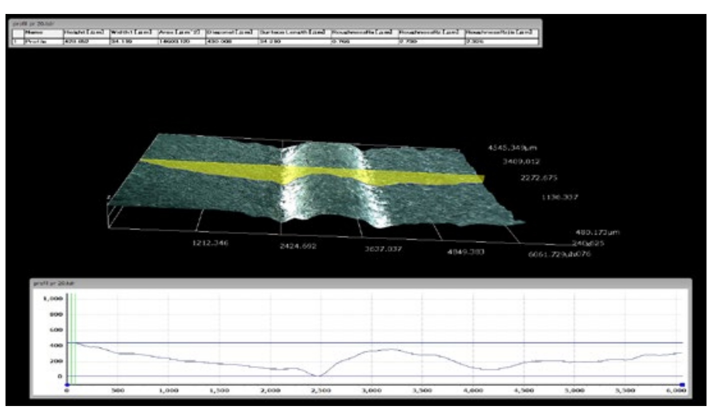
Fig. 2. Profile of laser padding welding sample, for the power of 3kW

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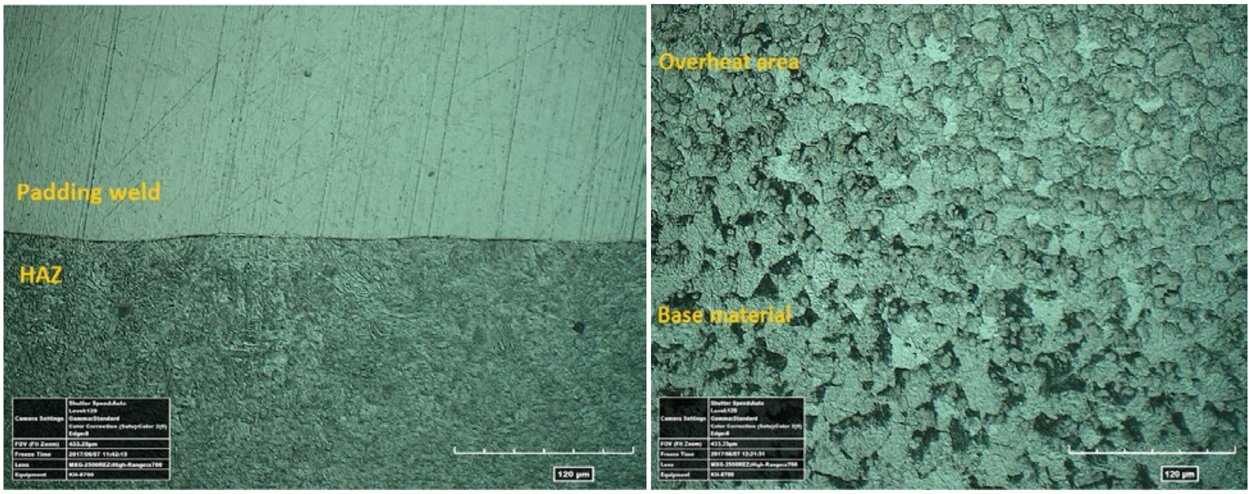
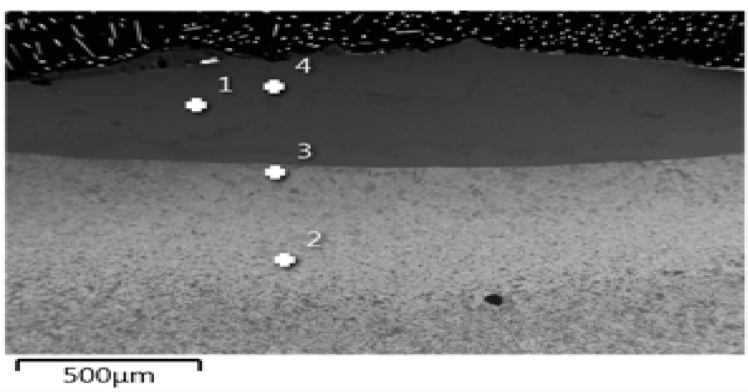


Fig 3. Microstructure of laser padding welding.

Figure 3 presents the results of microscopic testing. In the cross section of padding welding four characteristic areas were shown. Padding weld and the Heat Affected Zone (HAZ) were shown on the left and two similar microstructures of overheat area and base material (BM). The overheat area has little grain refining comparing to BM and its transition lattice between BM and HAZ.

Metallographic tests showed dissimilarity in the structure of the material. Chromium contained in the additive material improved hardenability in steels and might have caused structure transformation [6]. To further investigate this phenomenon, chemical distribution in cross section of padding welding (Fig 4.) would be conducted.



Sample	Al	Si	Cr	Mn	Fe	Ni	Nb	Mo
1		1.06	14.14	0.48	28.35	44.60	2.63	5.80
2				0.63	99.37			
3	0.23		0.08	0.47	99.22			
4		0.79	14.38		30.79	47.71	1.56	4.77

Fig 4. Measurement points of chemical composition, and amount of elements.

Chemical composition of selected points using a SEM microscope was carried out. For the achievement of padding welding characteristics, linear distribution of elements was conducted (Fig 5).

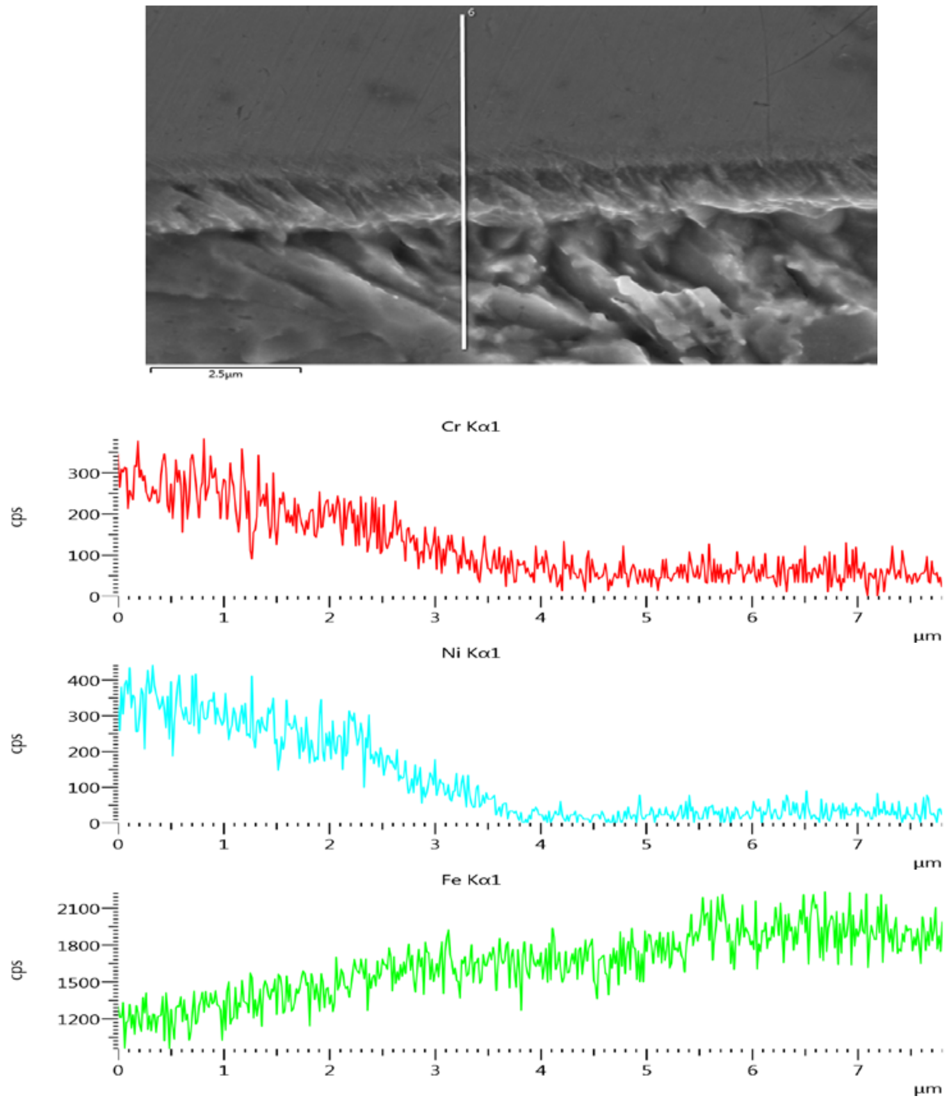


Fig 5. Linear distribution of Chromium, Nickel and Ferrite in a laser padding welding.

To investigate changes in mechanical properties of the padding welded material, microhardness tests were conducted. The results of the Vickers Hardness test with the load of 5kgF were shown below.

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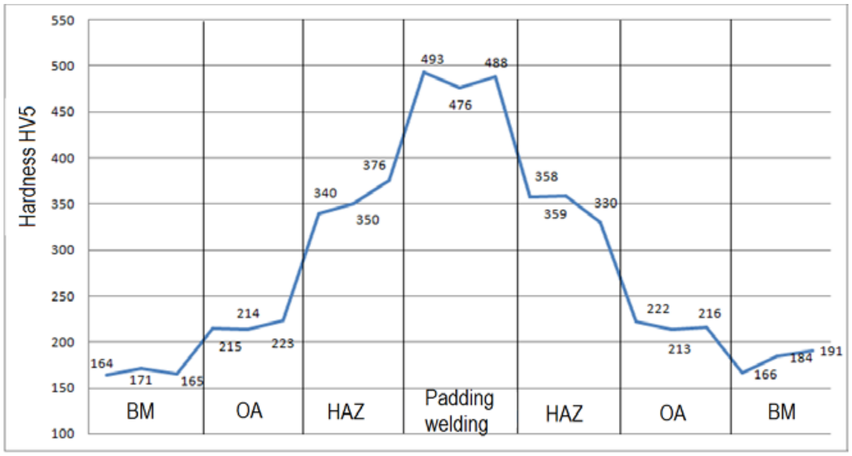

Fig 6. Microhardness test of laser padding welding results.

Laser padding welding rebuilding of connection rodsurface.

The experiment and results presented in the previous chapters were carried out to investigate proper padding welding parameters for the rebuilding of a connection rod surface. The wear surface was regenerated by metallic powder deposited on a cylindrical sphere of part (Fig 7.). After rebuilding, a sliding process to achieve nominal geometry is required.

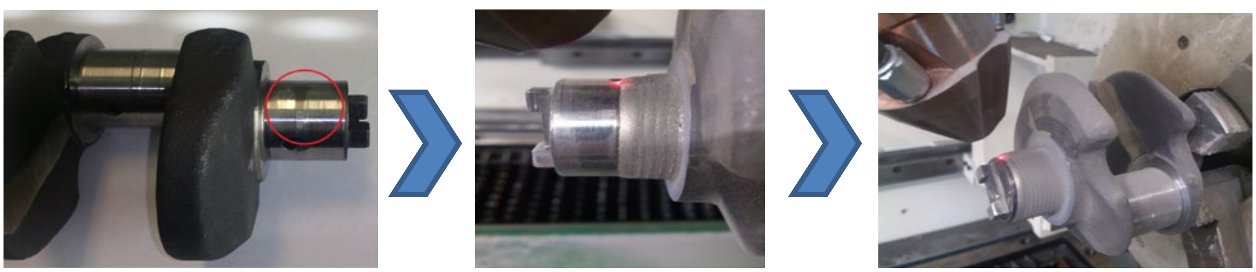

Fig 7. Rebuilding process of a connection rod surface using laser padding welding technology.

Summary

Rebuilding process using laser padding welding could be used to regenerate attrition surfaces. Using proper additive materials, surface properties could be modified. Laser padding welding characterized in the narrow heat affected zone in the material, and process power and ratio of velocity affect the metallographic structure of material by determining the amount of heat absorbed in the material. Improvement of material properties including hardness of padding welded surfaces affects the exploitation time of regenerated components [7,8].

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