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Laser Metal Deposition Welding in the Field of Tool and Mould Making

Markus Franz, Jens Bliedtner*, Conrad Haupt

Ernst-Abbe-Fachhochschule Jena, Carl-Zeiss-Promenade 2, 07745 Jena, Germany

Abstract

In mould and tool making laser metal deposition welding provides a new way of creating novel tool designs as well as the reconditioning of used tools. A great advantage is seen in the ability to establish multiple layers of different materials on one work piece in a single process. This can result in a specific structure of tools that allows a certain hardness or abrasion gradient towards the active surface or even a layer heat transfer inside the tool. One scientific approach is to influence the distribution of carbides. Furthermore the manipulation of the surface tension by the use of specific shielding gases provides an attempt. Throughout this project ways of process integration into mould and tool making will be taken care of while tackling some major challenges in this industry.

Keywords: LMD Welding; active gases; surface; carbide flow

1. Introduction

Throughout this scientific work concerning Laser Metal Deposition (LMD) Welding the influence of weld pool flow dynamics towards the welding powder particle distribution (e. g. tungsten carbide) inside the weld pool is examined and analysed. Figure 1 shows the experimental setup.

LMD Welding with powder based welding consumables allows the generation of three dimensional structures and functional layers made of different materials, also including hard substances, on a work piece, creating single layer thicknesses of 0,1 to 2 mm [2]. Hereby novel moulds, tools and various metal parts can be built up out of different metals. This special coating process's field of application therefor involves the mould and tool making

* Corresponding author. Tel.: +49-3641-205444; fax: +49-3641-205351.
E-mail address: jens.bliedtner@fh-jena.de

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industry, which is well known for its special material properties and requirements and complex tool structures. Advantages provided by LMD welding, in comparison with conventional processes such as metal arc welding, involve the regeneration and optimization of tools, the substitution of component parts and the generation of gradient coatings and wear-protection layers.

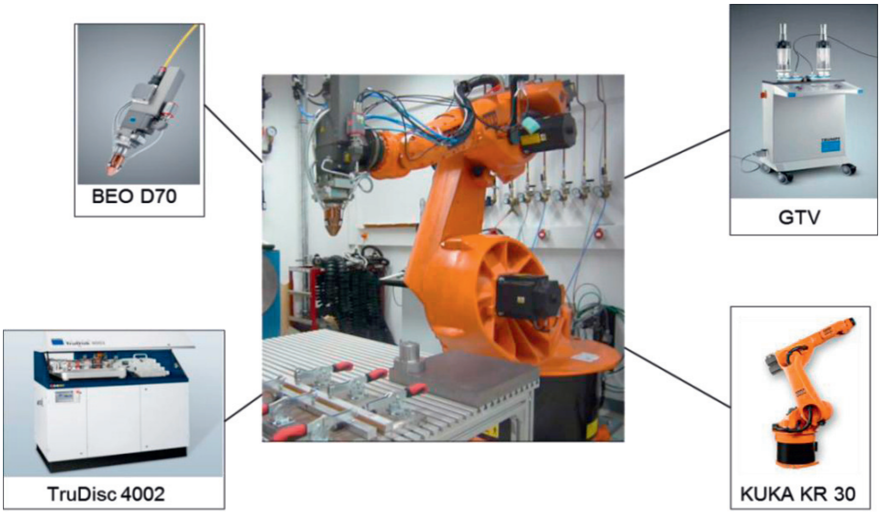

Fig. 1. Experimental setup for Laser Metal Deposition Welding (LMD) [1].

2. Experimental procedure

Figure 2 shows the influence of various gases on the temperature of the weld pool surface. This temperature can be influenced by the shielding gas. In this experiment, a shielding gas mixture with helium base is used. Carbon dioxide, oxygen and nitrogen are added to the helium base.

Carbon dioxide and oxygen are both active gases, generating higher surface temperatures of the weld pool compared to helium and nitrogen. The change of the surface temperature of the weld pool results in a change of surface tension and shear stress at the melt surface. Figure 3 shows the dependency of the melt pool flow from the surface temperature. If the temperature gradient's algebraic sign is negative, then the weld pool flow direction behaves as presented in the lower picture of figure 3. The flow velocity depends on the increase of the temperature gradient. If the increase of the temperature gradient is high, then the melt pool flow velocity increases. A typical range for the melt flow velocity is about 1 to 10 m/s [3].

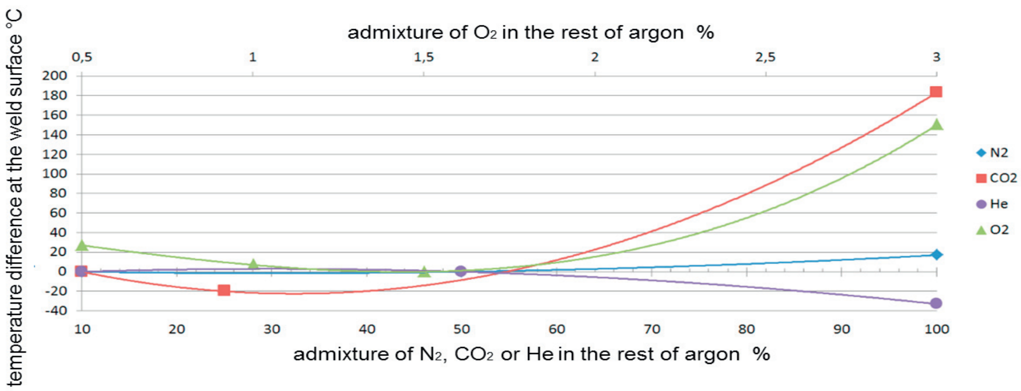

Fig. 2. Influence of various gases on temperature of the weld surface.

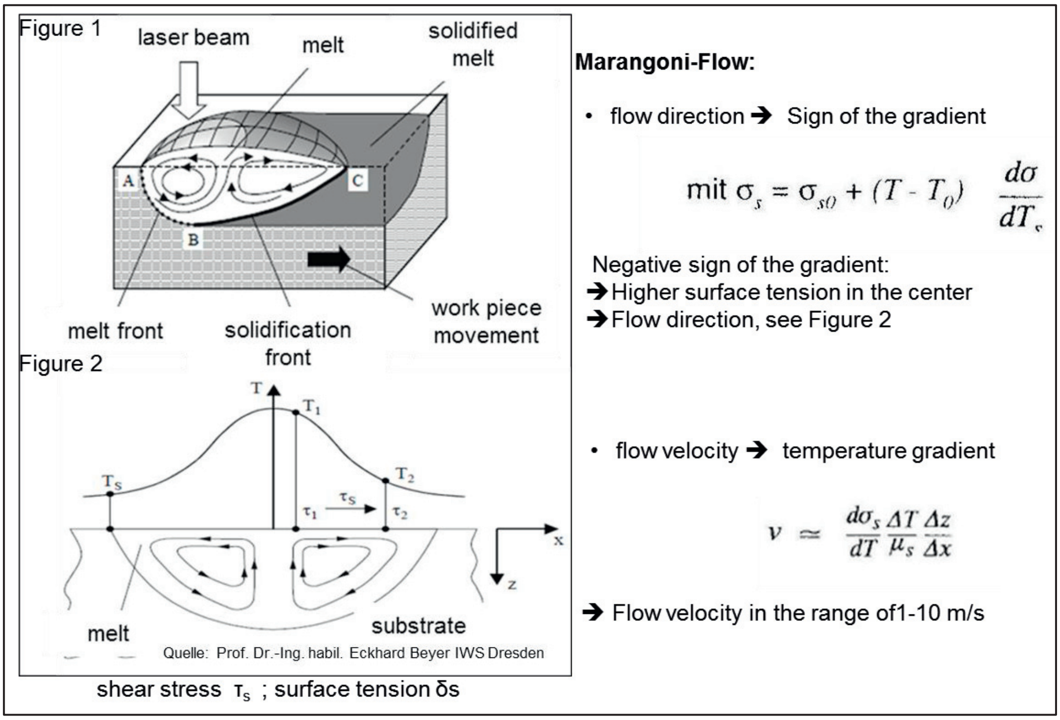

Fig. 3. Influence of carbide flow in the melt [3].

3. Summary

The regeneration and optimization of tools, the substitution of component parts and the generation of gradient coatings and wear-protection layers are different complex operations in welding. To enable an easy way for all of those processes LMD welding provides one key technology. Even an influence on the particle distribution can be achieved, since a homogeneous distribution of additives (e. g. carbides) throughout the weld pool area is not always desired or useful. When post-processing the part's surface by milling or grinding a hardness increase in the lower area of the weld pool is necessary, whereas a lower hardness supports the tooling process. This will result in longer tool lives, shorter machining times and all in all lower production costs per part. Figure 4 shows one homogeneous and one inhomogeneous accumulation of carbide particles in the cross-section of a welding track.

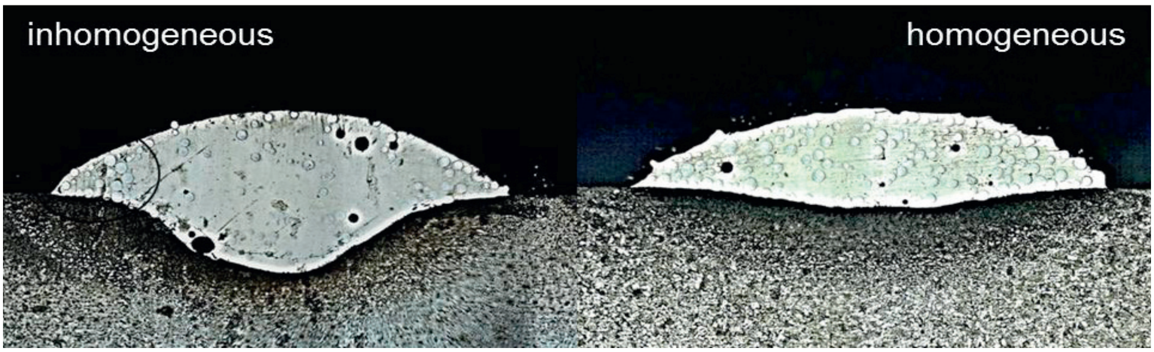

Fig. 4. One homogeneous and one lowered accumulation of carbides.

In industrial fields such as mould and tool making great amounts of working time are used for the repair and the regeneration of large tools. The complexity of modern tools thereby often limits the applicability of conventional repair methods. Introducing a new technology in this context facilitates novel possibilities of tool regeneration and manufacturing, such as metallic gradient coatings. Because of its high capacity for automation and the comparably low heat input into the component part LMD welding represents a promising example of such. In cooperation with representatives of the tool and mould making industry and an automation specialist the basis for a broad application of LMD is now provided at the laboratory of the University of Applied Sciences Jena. The technology is applicable as well as ready to be included in continuing research [4].

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References

[1] Trumpf Lasertechnik website, Pictures from http://www.de.trumpf.com/produkte/lasertechnik.
[2] Metzger, J.; Dem Verschleiß die Stirn bieten, Pages 38-41, Laser und Produktion, 2008.
[3] Beyer E.; Wissenbach K.; Oberflächenbehandlung Mit Laserstrahlung, Springer 1998.
[4] Haupt, C.; Franz, M.; Bliedtner, J.; Entwicklung einer Prozesskette für das automatisierte Laser-Pulver-Auftragschweißen im Werkzeug- und Formenbau, Tagungsbeitrag, 22. IWKM, 2012.