Available online at www.sciencedirect.com

ScienceDirect

Physics Procedia 56 (2014) 885 – 891

Physics Procedia

8th International Conference on Photonic Technologies LANE 2014

Measurement of cut front properties in laser cutting

Thombansen, Ulrich[1,*]; Hermanns, Torsten[3]; Molitor, Thomas[2]; Pereira, Milton[4]; Schulz, Wolfgang[3]

[1] RWTH Aachen University, Chair for Laser Technology (LLT), Aachen, Germany
[2] Fraunhofer Institute for Lasertechnology (ILT), Aachen, Germany
[3] RWTH Aachen University, Nonlinear Dynamics of Laser Processing (NLD), Aachen, Germany
[4] Federal Institute of Santa Catharina Catarina (IFSC), Santa Catarina, Brazil

Abstract

Cut-front properties are a key variable in laser-cutting and thus of major importance for self-optimization. Within the Cluster of Excellence at RWTH Aachen University, several achievements were made in setting up sensor-systems that provide information on the operating-point of this melt-based manufacturing process. These achievements contribute to a gradual increase in system-transparency which is seen as an enabler for self-optimization.

Instead of searching for a single measurand to characterize the course of the process, an approach is being presented which establishes a surrogate criterion to allow determination of the current operating-point. In the depicted area, this is done by joining sources of information from process observation, determining boundary-conditions such as actual feed-rate and modeling of process-variables. Although process-variables like properties of the cutting-front are influenced through more than one process parameter, a concept for a sensor-system is reported showing the correlation between properties of the melt-front and the current feed-rate. The results are compared to a solution derived from process-simulation.

© 2014 Published by Elsevier B.V. This is an open access article under the CC BY-NC-ND license (http://creativecommons.org/licenses/by-nc-nd/3.0/).
Peer-review under responsibility of the Bayerisches Laserzentrum GmbH

* Corresponding author. Tel.: +49-241-8906-320; fax: +49-241-8906-121 .
E-mail address: ulrich.thombansen@ilt.fraunhofer.de

1875-3892 © 2014 Published by Elsevier B.V. This is an open access article under the CC BY-NC-ND license (http://creativecommons.org/licenses/by-nc-nd/3.0/).
Peer-review under responsibility of the Bayerisches Laserzentrum GmbH
doi:10.1016/j.phpro.2014.08.107

1. Introduction

Laser cutting is used in several areas of manufacturing as in processing of flat metal sheets for construction, cutting of pre-formed parts in the white goods industry or trimming of hardened 3D parts in the automotive sector. All these variants require a reliable cutting performance, some with special requirements to cut face roughness, some with the need for dross free processing results. Common to all of them is the strive for both maximum cut length per time at full separation. Today, cutting machines operate with setting parameters which offer a stable process window accounting for the most relevant disturbances that might occur during processing of material in a real world scenario. From a scientific point of view, it is of major interest to establish a feature which qualifies the current operating point of a laser cutting process which at the same time can be associated to a process model. Research on contributions towards self-optimizing manufacturing systems has already shown first results (Thombansen et al., 2012).

Several approaches have been reported which focused on acquiring signals of the process which are relevant to the processing result (Chen, 1997) (De Keuster et al., 2007). All of these have added to process understanding but differ in applicability to industrial systems. In normal operation of a laser cutting system, coaxial process observation can be introduced without interfering with the process or with the performance of such a machine. With coaxial illumination of the interaction zone, it allows to acquire information about geometric properties of the cut during processing namely the melting point. This feature can also be quantified by modeling making it an ideal feature to determine the operating point. As such, it contributes to the advance towards a self-optimizing laser cutting system.

2. Approach

The position of the melting point can be qualified twofold, theoretically by a process model and practically by a process observation system (Thombansen et al., 2013). As both solutions provide results on a different physical scale, a surrogate criterion has to be established which links both solutions to such an extent that control can be executed.

On the side of the process model, the absorption of the laser beam is used to establish a physical balance based on the beam caustic, the absorption of the material and the feed rate. Based on the Stefan Signorini condition, a two dimensional model is applied which leads to a description of the geometric shape of the melt front. This shape is used to establish the surrogate criterion.

From the coaxial perspective, the surface of the metal sheet can be observed resulting in an image of the sheet with the cut. Illuminating the surface and capturing the reflection by means of a high speed camera allows determining areas with reflection from metal sheet surface, and areas without reflection – the kerf. The intensity distribution in the image is used to establish the surrogate criterion from the side of the process observation.

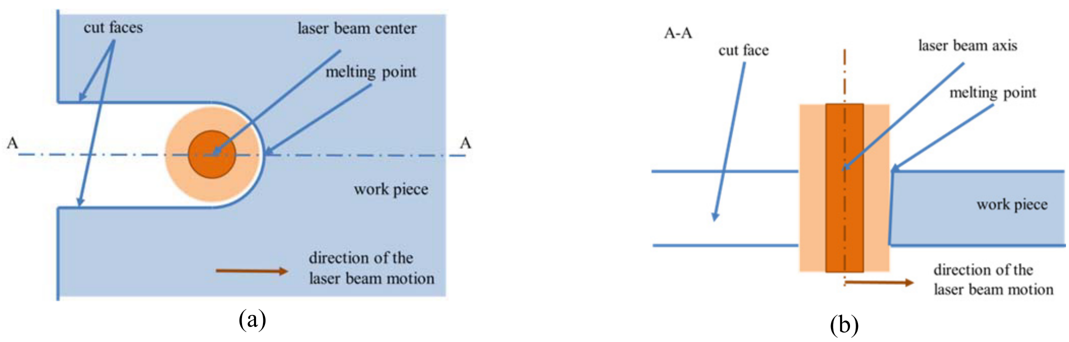

Fig. 1. Sketch describing the position of the melting point (a) top view; (b) cross cut at A-A.

Download English Version:

https://daneshyari.com/en/article/1871786

Download Persian Version:

https://daneshyari.com/article/1871786

Daneshyari.com