PROCEEDINGS

of the Union of Scientists - Ruse

Book 5

Mathematics, Informatics and Physics

Volume 10, 2013

RUSE

The Ruse Branch of the Union of Scientists in Bulgaria was founded in 1956. Its first Chairman was Prof. Stoyan Petrov. He was followed by Prof. Trifon Georgiev, Prof. Kolyo Vasilev, Prof. Georgi Popov, Prof. Mityo Kanev, Assoc. Prof. Boris Borisov, Prof. Emil Marinov, Prof. Hristo Beloev. The individual members number nearly 300 recognized scientists from Ruse, organized in 13 scientific sections. There are several collective members too – organizations and companies from Ruse, known for their success in the field of science and higher education, or their applied research activities. The activities of the Union of Scientists – Ruse are numerous: scientific, educational and other humanitarian events directly related to hot issues in the development of Ruse region, including its infrastructure, environment, history and future development; commitment to the development of the scientific organizations in Ruse, the professional development and growth of the scientists and the protection of their individual rights.

The Union of Scientists – Ruse (US – Ruse) organizes publishing of scientific and popular informative literature, and since 1998 – the “Proceedings of the Union of Scientists- Ruse".

BOOK 5

"MATHEMATICS, INFORMATICS AND PHYSICS"

VOLUME 10

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BOOK 5

"MATHEMATICS, INFORMATICS AND PHYSICS"

VOLUME 10

This is the jubilee 10-th volume of book 5 Mathematics, Informatics and Physics. The beginning was in Spring, 2001, when the colleagues of the former section Mathematics and Physics decided to start publishing our own book of the Proceedings of the Union of Scientists – Ruse. The first volume included 24 papers. Through the years there have been authors not only from the Angel Kanchev University of Ruse but as well as from universities of Gabrovo, Varna, Veliko Tarnovo and abroad – Russia, Greece and USA.

Since the 6-th volume the preparation and publishing of the papers began to be done in English.

The new 10-th volume of book 5 Mathematics, Informatics and Physics includes papers in Mathematics, Informatics and Information Technologies, Physics and materials from the Scientific Conference 'Information Technologies in Education' (ITE), held at the University of Ruse in November 2012 in the frame of Project 2012-FNSE-02.

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DETERMINATION OF PRELIMINARY INTERVALS OF THE SPEED OF LASER WELDING ON ELECTRICAL STEEL

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Abstract: *Numerical experiments on determination of preliminary intervals on the speed of laser welding of electrical steel M530-50A were conducted. They refer to a diode laser and CO_2-laser. The obtained graphic dependences between the maximum depth of the melt and the speed for two types of lasers were compared and analyzed.*

Keywords: *laser welding, electrical steel, diode laser, CO_2-laser, preliminary intervals.*

INTRODUCTION

On the laser welding process influence a number of factors related to:

- Material properties - optical characteristics (reflectance, absorption, penetration depth) and thermo-physical properties (thermal conductivity, thermal diffusivity, specific heat capacity).
- Laser parameters - power, power density and volume density of absorbed energy.
- Technological parameters - speed, defocusing.

These factors are in particular physical dependencies between them. They are important for the understanding of the physical nature of the process [1, 2]. The speed, in conjunction with the power density, is a basic factor in the realisation of the research process.

The objective of the work is to obtain preliminary speed intervals through numerical experiments on laser welding of products of electrical steel from M530-50A. They are necessary to reduce the timing of real experiments in the study of this process.

EXPERIMENT

1. Used software, material and lasers

In conducting numerical experiments is used a specialized software TEMPERATURFELD3D [3] - the working environment for the calculation of temperature fields with a wide range of input parameters and capabilities for analysis of the calculated results. For the calculations are necessary the following input parameters: program parameters; geometric parameters; parameters of the laser; parameters of the material.

After the calculations, on the output are received the following options: approximation of the results; animation of the entire process; temperature profile of the material at a particular moment of time; profile of the maximum temperature; dependence on the temperature from the time; amendment on the temperature of material in depth.

The experiments are related to electrical steel M530-50A, which is widely used in the manufacturing process of rotor and stator packs for electric motors [4, 5, 6]. The chemical composition of the steel is shown in Table 1.

Two laser systems with diode laser [7] and CO_2-laser [8] are used. Their parameters are shown in Table 2 and are suitable for welding steels.

Table 1

Element	C	Si	Mn	P	S	Cr	Mo	Aℓ
Content, %	0,027	1,45	0,236	0,097	0,020	0,06	0,021	0,358

Table 2

Laser Parameter	Diode laser	CO_2-laser
Wavelength λ, nm	1070	10 600
Power P, W	6000	5 000
Frequency ν, kHz	continuous wave (cw)	continuous wave (cw)
Beam quality M^2	< 10	< 10
Positioning accuracy, µm	2,5	2,5
Efficiency, %	40	20

2. Results for Diode laser

In order to determine the intervals of changing of speed at different power densities, the dependence between the depth of the melt and the speed for the two lasers is examined.

With the use of the program Temperaturfeld3D a series of numerical experiments were held; the speed changes in the interval v Є [20, 120] mm/s with a step 10 mm/s. From the obtained temperature fields on the surface of the sample and layer by layer is determined the depth of the melt. In Fig. 1 are shown the temperature fields of the speed v = 70 mm/s and power density of the laser radiation q_S = 6,19.10^9 W/m^2. On the surface of the sample (h_1 = 0) and in layers 2 (h_2 = 100 µm), 3 (h_3 = 200 µm) and 4 (h_4 = 300 µm), the temperature of the specimen in the impact zone is above the melting point.

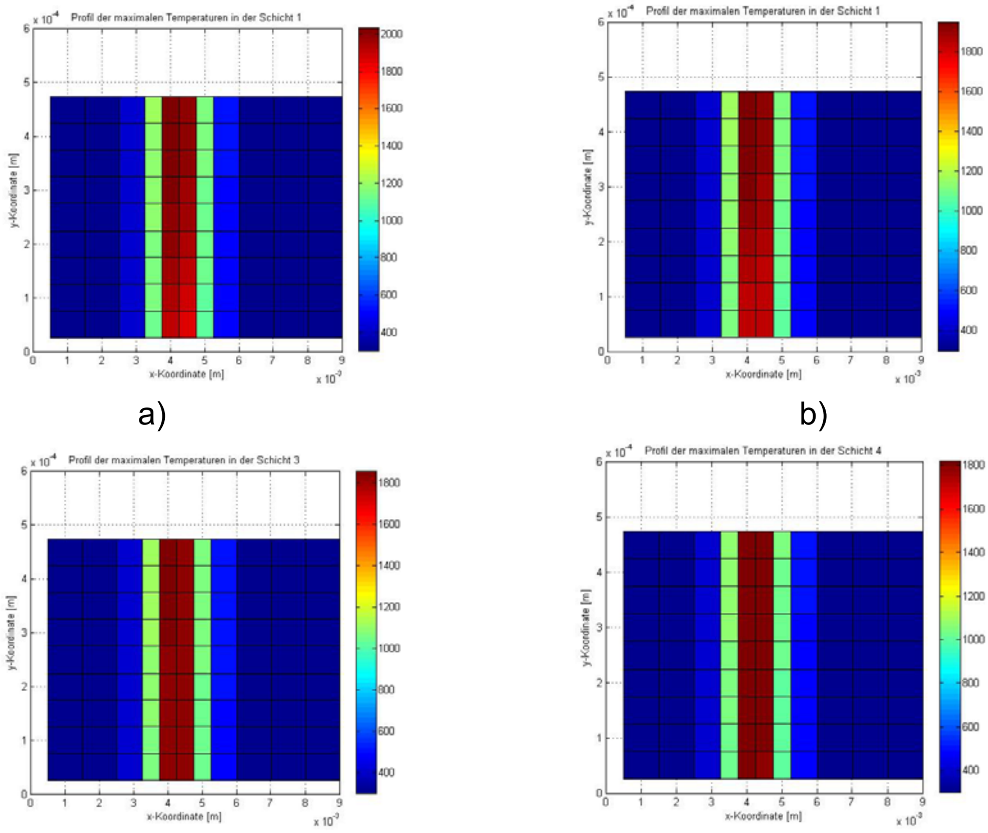

Fig. 1.

The results are summarized in Fig. 2, where graphs of the dependencies of the depth of the melt *h* to the speed of welding *v* are presented: 1 - for the power density q_S = $6{,}19.10^9$ W/m^2; 2 - for the power density q_S = $7{,}43.10^9$ W/m^2. From their analysis can be drawn the following conclusions:

- With the increasing of speed is observed a decrease in the depth of the melt. It is explained by the fact that with the increasing of speed the time for impact is reduced. Also, this reduces the energy absorbed in the impact zone, the volume and depth of the melt.
- The average speed of the reduction of the depth of melt is 4,30 μm/(mm/s) for power density q_S = $6{,}19.10^9$ W/m^2 and 5,70 μm/(mm/s) for q_S = $7{,}43.10^9$ W/m^2.
- Intervals for the speed of laser welding are received:

- *v* Є [20, 57] mm/s for power density q_S = $6{,}19.10^9$ W/m^2;
- *v* Є [20, 94] mm / s for power density q_S = $7{,}43.10^9$ W/m^2.

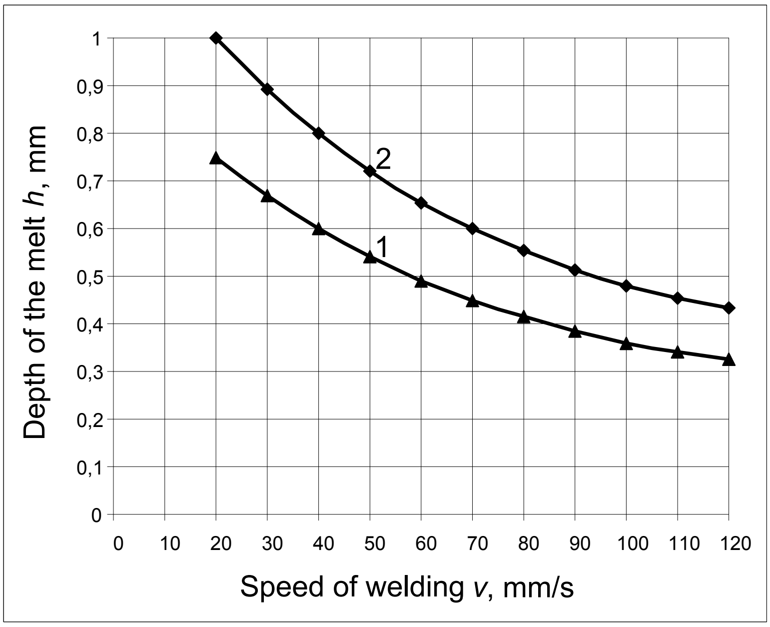

Fig. 2.

3. Results for CO_2-laser

A series of numerical experiments were conducted; the speed changed its interval *v* Є [20, 120] mm/s with a step of 10 mm/s, and the power density of the laser radiation was kept constant. In Fig. 3 is shown a graph of the dependence between the depth of the melt and the speed of welding: 1 - for the power density q_S = $1{,}23.10^{10}$ W/m^2; 2 - for the power density q_S = $1{,}56.10^{10}$ W/m^2. From these could be drawn the following conclusions:

- With the increasing of speed is observed a decrease in the depth of the melt.
- The average speed of reduction of the depth of melt is 4,00 μm/(mm/s) for power density q_S = $1{,}23.10^{10}$ W/m^2 and 5,20 μm/(mm/s) for q_S = $1{,}56.10^{10}$ W/m^2.
- Power density of laser radiation for the CO_2-laser is more than two times larger than that of the diode laser; the melt depth for the studied range of speed is almost the same. This is explained by the larger absorption of the radiation of diode laser compared to that of the CO_2-laser for electrical steel M530-50A.
- Intervals of the speed of laser welding are received:

- *v* Є [20, 53] mm / s for power density q_S = $1{,}23.10^{10}$ W/m^2;
- *v* Є [20, 80] mm / s for power density q_S = $1{,}56.10^{10}$ W/m^2.

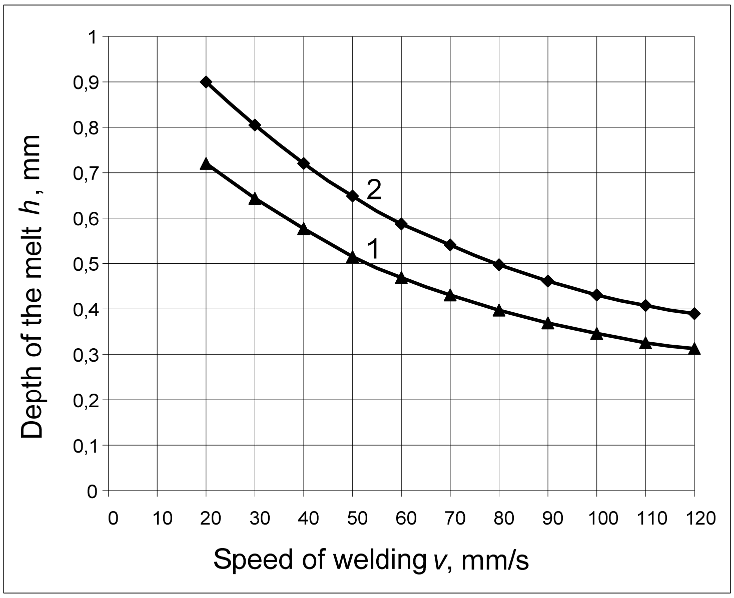

Fig. 3.

CONCLUSION

The received intervals are the preliminary step for the optimization of the process of laser welding of electrical steel products. Numerical experiments can be supported by the study of the influence of the power density of laser radiation on the depth of the melt. These results can serve as a basis for further experiments related to the study of the process.

REFERENCES

[1] Grigoryanc A., I. Shiganov, A. Misyurov, Tehnologicheskie procesi lazernoi obrabotki, izd. MGTU im. N. E. Baumana, Moskva, 2006.

[2] Georgiev D., I. Chomakov, B. Bogdanov, Viscosity Behaviour of Cristalizing Glass-Forming Melts, Comptes rendus de l'Academie bulgare des Sciences, Vol. 57, N 12, 2004, 55-60.

[3] Belev I., Sreda za presmyatane na lazerno inducirani temperaturni poleta, diplomna rabota, Tehnicheski universitet, Gabrovo, 2009.

[4] Bal G., D. Uygun, A Novel Switched Reluctance Motor with U-type Segmental Rotor Pairs: Design, Analysis and Simulation Results, World Academy of Science, Engineering and Technology 40, 2010.

[5] Fodorean D., D. Popa, F. Jurca, M. Ruba, Optimizing the Design of Radial/Axial PMSM and SRM used for Powered Wheel-Chairs, World Academy of Science, Engineering and Technology 59, 2011.

[6] Michailidis P., Magnetic Analysis of the Synchronous machine and the Supporting Structure, www.feec.vutbr.cz/EEICT/2011/sbornik/03-Doktorske%20 projekty/04-Silnoprouda%20elektrotechnika%20a% 20elektroenergetika/14-xmicha33.pdf.

[7] www.arci.res.in/clp/6-kw-diode-laser.html

[8] www.trumpf.com

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ОПРЕДЕЛЯНЕ НА ПРЕДВАРИТЕЛНИ ИНТЕРВАЛИ ЗА СКОРОСТТА НА ЛАЗЕРНО ЗАВАРЯВАНЕ НА ЕЛЕКТРОТЕХНИЧЕСКА СТОМАНА

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Резюме: *Числени експерименти на предварителни интервали за скоростта при лазерно заваряване на електротехническа стомана M530-50A са проведени. Те се отнасят за диоден лазер и CO_2-лазер. Получените графични зависимости на максималната дълбочина на стопилката от скоростта за два типа лазери са сравнени и са анализирани.*

Ключови думи: *лазерно заваряване, електротехническа стомана, диоден лазер, CO_2-лазер, предварителни интервали.*

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