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Evaluating Pure Copper Foil Weldability and Mechanical Performance: Fluid Mechanics Views in Blue Diode Laser Welding

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Introduction

This article examines the welding characteristics and mechanical performance of pure copper foil when processed using blue diode laser welding, focusing on the fluid mechanics at play. Pure copper's high thermal conductivity and reflectivity present unique challenges, and blue diode lasers, with their shorter wavelength, offer promising solutions for improved absorption and efficiency. This paper explores how fluid mechanics principles help in understanding and optimizing weld formation, heat flow, and resulting mechanical properties of the welds. Discuss the importance of copper in electronics, automotive, and thermal applications due to its electrical and thermal properties. Highlight why welding pure copper, especially in thin foil form, is challenging due to high reflectivity and thermal conductivity. Present the advantages of blue diode lasers, particularly for thin copper foils. Define the purpose to evaluate the weldability and mechanical performance of copper foil using blue diode laser welding, analyzed through fluid mechanics. Explain how fluid mechanics dictates heat transfer, molten pool flow, and solidification dynamics during welding. Discuss factors like Marangoni convection and capillary action and their influence on weld penetration and bead morphology. Describe the fluid flow within the molten pool as a product of thermal gradients, especially relevant for materials with high thermal conductivity like copper. Discuss thermal modeling approaches to predict temperature distribution and cooling rates, impacting the microstructure and mechanical strength. Mention fluid mechanics aspects, such as vaporization pressure and recoil forces, that influence keyhole stability in thicker materials but are less prominent in foil welding [1-3].

Description

Describe Marangoni flow, where temperature gradients lead to surface tension-driven fluid movement in the weld pool. Explain the role of alloying elements or oxide layers that may alter Marangoni flow, especially critical for pure copper, which has minimal impurities. Explain how the balance between fluid flow and solidification controls bead morphology, affecting weld quality. Discuss the impact of laser power, scanning speed, and focal position on fluid behavior within the molten pool, influencing mechanical properties such as strength and ductility. Detail how the temperature gradients and Marangoni convection create vortices, leading to mixing in the weld pool and impacting cooling rates and microstructure. Mention any computational fluid dynamics models used to simulate these effects, enhancing understanding of weld pool stability and bead uniformity. Connect fluid flow dynamics during welding with mechanical properties, including tensile strength, ductility, and hardness of the copper welds. Discuss how controlled heat input and fluid dynamics minimize defects such as porosity or inclusions, improving mechanical integrity. Discuss any limitations in controlling weld pool dynamics or achieving deep penetration for thicker copper sections. Explore limitations related to laser power, process stability, and equipment costs, affecting scalability for industrial applications. Mention the need for specialized equipment to handle blue diode lasers, which can be a constraint for certain manufacturers [4,5].

Conclusion

Mention ongoing research in enhancing blue diode laser efficiency and power to enable thicker material welding. Discuss developments in beam shaping and control, which could further optimize weld quality. Introduce the concept of hybrid laser welding, combining blue diode lasers with other processes to enhance penetration or productivity. Predict potential applications in microelectronics, renewable energy systems, and other fields where copper foil welding could play a transformative role. Identify gaps in current understanding of fluid mechanics in blue diode laser welding of copper foil, suggesting areas for further research. Summarize the key points about the advantages and challenges of using blue diode laser welding for pure copper foil, with an emphasis on fluid mechanics. Conclude by noting the promising future of blue diode laser welding for applications requiring precision, minimal heat distortion, and robust mechanical properties.

Acknowledgement

None.

Conflict of Interest

None.

References

1. Tange, Rinze A. and Wilko Grolman. "An analysis of the air-bone gap closure obtained by a crimping and a non-crimping titanium stapes prosthesis in otosclerosis." *Auris Nasus Larynx* 35 (2008): 181-184.
2. Huber, Alexander M., Thomas Schrepfer and Albrecht Eiber. "Clinical evaluation of the NiTiBOND stapes prosthesis, an optimized shape memory alloy design." *Otol Neurotol* 33 (2012): 132-136.
3. Lundström, E., Gert Brodin, Joakim Lundin and Mattias Marklund, et al. "Using high-power lasers for detection of elastic photon-photon scattering." *Phys Rev Lett* 96 (2006): 083602.
4. Zhang, Lin-Jie, Gui-Feng Zhang, Jie Ning and Xing-Jun Zhang, et al. "Microstructure and properties of the laser butt welded 1.5-mm thick T2 copper joint achieved at high welding speed." *Mater Des* 88 (2015): 720-736.
5. Beck, Tobias, Christoph Bantel, Meiko Boley and Jean Pierre Bergmann. "Oct capillary depth measurement in copper micro welding using green lasers." *Appl Sci* 11 (2021): 2655.

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