Transilvania University of Brasov

HABILITATION THESIS

SUMMARY

LASER CLADDING: FROM EXPERIMENTAL RESEARCH TO INDUSTRIAL APPLICATIONS

Domain: Industrial engineering

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My PhD thesis entitled *Improvement of mechanical properties of automotive parts through laser cladding*, which was defended in 2011, addresses the laser technology focused on the reconditioning of automotive components by coaxial laser cladding. During my PhD studies, I was fascinated by the endless possibilities offered by the LASERS in terms of materials processing and by the fast evolution of this technology. After finishing the PhD programme, my passion and interest in laser technologies continued through further work, study and research in this direction.

Laser cladding with powders has been my main research direction over the last eight years, and it has allowed me to obtain high-quality coatings by fine tuning the laser cladding process and by designing new composite materials. The entire research activity was a continuous tandem between the fundamental based research and applied research of laser cladding technology.

This thesis presents the continuation of my research activity after the PhD was defended. The habilitation thesis entitled **Laser cladding: from experimental research to industrial applications** is written as a collection of published articles in the field of laser cladding and can be divided into three parts, i.e., **state of the art**, **fundamental research** and **industrial applications**, which highlight the personal scientific and professional achievements, as well as further development plans in my academic career.

A brief description of the main professional achievements during my academic career is presented in the first part of the habilitation thesis. Then, the scientific achievements are presented in 4 chapters, as follows.

Chapter one addresses the laser cladding technology from a theoretical point of view. A short review of the state-of-the-art developments helps to familiarise the reader with the laser technology and with different laser cladding techniques. A short literature survey focusing on the parameters for optimization, the materials used for cladding, and amorphous or nanocomposite claddings is presented at the end of this chapter.

The **second chapter** presents my contributions to the laser cladding research with nickel-based powders, especially the Inconel 718 alloy. The first achievement is the fine tuning of the

coaxial laser cladding process parameters and obtaining crack free and dense cladded layers. The second achievement presented in this chapter is the further improvement of Inconel 718 mechanical characteristics by applying a heat treatment with concentrated solar radiation.

The third chapter gathers the results obtained by using different advanced laser cladding techniques and composite materials. A first contribution presents a novel approach in designing crack free composite materials by fabricating a dual layer coating formed by a buffer layer and a hard coating. Furthermore, development of new amorphous coatings or adding carbon nanotubes as reinforcement in nickel coatings are other original contributions presented in the second part of this chapter.

The fourth chapter is focuses on industrial applications of the laser cladding technology research. Within this chapter, two case studies concerning the reconditioning of worn components by laser cladding are presented. The first case addresses the reconditioning of several moulds used in the hot compression moulding process designated for the automotive industry. The moulds have been successfully repaired by fabricating a laser-cladded layer of NiCrBSiFe.

The second case study involves reconditioning of a VT3-1 titanium compressor blade used in the aviation industry. Pure titanium powder was used for creating a thin laser cladded track on the edge of the blade. The results show that laser cladding with Metco 4010 powder can be used as an effective method for reconditioning a damaged compressor or jet engine titanium blade.

The last section of the habilitation thesis presents my plans for further developing my academic career. In the light of the abovementioned achievements, the further direction of my research activity is summarized as follows:

- Realizing a novel laser cladding technique with improved capabilities in terms of mixing powders with different mass densities;
- Continuing the research in the field of laser technology, with the aim to develop a new laser surface modification procedure based on laser heat treatment and laser shock processing;

- Continuing the research in the field of carbonaceous material synthesis using solar radiation;
- Submitting patent proposals containing the already obtained results is a short-term action plan.

The contributions presented in this habilitation thesis are based on 12 published articles journal indexed in international databases.

The entire research activity is based on more than 50 published articles, of which 36 are indexed in Web of Science Core Collection, and 22 have impact factors. In addition, I was the director (4) or a member (9) of the research team of 13 national or international research grants and member of 2 international research project teams with third-party European companies. The results are recognized by the academic community through citations in prestigious journals (Optics and Laser Technology, Materials and Manufacturing Processes, Surface and Coatings Technology and so forth.), and the Scopus and Web of Science Hirsh index is 5.