

**University POLITEHNICA of Bucharest**



## **HABILITATION THESIS**

### **THEORETICAL AND EXPERIMENTAL CONTRIBUTIONS IN THE WELDING TECHNOLOGIES FIELD**

**Industrial Engineering**

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## ABSTRACT

The habilitation thesis „Theoretical and Experimental Contributions in the Welding Technologies Field” briefly presents the results of the scientific research activity which the author carried out over the last 10 years, after obtaining the PhD scientific title in Industrial Engineering, in 2009. For the most part the research activities were carried out within the laboratories of the Department of Quality Engineering and Industrial Technologies, Faculty of Industrial Engineering and Robotics, University "POLITEHNICA" of Bucharest.

Following the PhD thesis, the author’s research activity focused on two main directions, which are briefly presented in this habilitation thesis:

- theoretical and experimental research on the possibilities of welding reconditioning of prostheses and medical instruments made of biocompatible materials;
- theoretical and experimental research on the possibilities of welding reconditioning of the crankshaft components used in the automotive industry.

The thesis is structured in 3 parts and is based on over 30 research projects in which the author participated as project manager or collaborator, 29 scientific papers published in journals or volumes of ISI Web of Science indexed conferences, 35 articles published in journals / conferences indexed in other international databases and two patent applications.

The first part of the thesis presents the author’s professional evolution, his main academic and scientific achievements, as well as the need for reconditioning by welding of products, parts or components.

At national and global level, the customized product market is constantly growing due to customers’ specific requirements for unique products that reflect their needs, taste and personality. In this context, the researches carried out since the completion of the PhD thesis aimed at analysing the possibilities of using the welding and / or reconditioning processes for medical instruments and the customization of medical prostheses (aesthetic and/or functional) as well as of endoprostheses (implanted prosthesis).

The first part of the thesis continues with the presentation of the results obtained following the research carried out on the possibility of obtaining prostheses and medical instruments using modern additive manufacturing processes. For these purposes, samples from Ti-6Al-4V and Co-Cr powders were analysed from the point of view of the chemical

composition, the mechanical properties and the quality of the resulting surfaces, by using the Direct Metal Laser Sintering – DMLS process.

Based on the results obtained from the research, the research team developed the welding reconditioning technology used for the adjustment (in the first case study) and the restoration (in the second case study) of the structural form of an acetabular prosthesis. After designing and optimizing the 3D prosthetic model by using the finite element analysis method, the prosthesis was partially made with the help of DMLS. Additional gripping ears for attaching the prosthesis to the bone structure were added in order to increase the stability of the implant by using the tungsten inert gas process (TIG).

The second case presented in the thesis refers to the restoration of the structural form of the acetabular prosthesis detached from the support holders during the DMLS process. Although the prosthesis was initially considered as waste, it was rebuilt according to the 3D design by using the welding reconditioning processes. The welding reconditioning costs amounted to about 10% of the manufacturing costs for a new prosthesis.

Another case study analysed in the experimental research is the optimization of the welding reconditioning technology of an intramedullary nail prosthesis. The second reconditioning technology was developed starting from the experimental results obtained by applying the first welding reconditioning technology for the intramedullary nail prosthesis and using the finite element analysis.

The end of the first part contains the presentation of several results of the experimental researches on the welding reconditioning possibilities of the crankshaft components used in the automotive industry. The crankshaft elements subjected to welding reconditioning were: main journals, crankpin journals and counterweights. In addition to the classic reconditioning technique, two other modern reconditioning techniques were used: weld toe tempering and the sided layers filling technique.

**The second part** of the habilitation thesis presents, within three subchapters, the evolution and development plans for the author's professional and scientific career, as well as the author's plans to collaborate with the industry.

**The third part** of the habilitation thesis contains a list with the 133 bibliographic references consulted by the author.