Universitatea Transilvania din Brașov

HABILITATION THESIS

ABSTRACT

Title: RESEARCH ON THE APPLICATION OF INNOVATIVE TECHNOLOGIES IN ADVANCED MATERIALS ENGINEERING

Domain: Materials Engineering

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This habilitation thesis synthesizes the research and results obtained since the defense of my Doctoral Thesis, "Research on Modern Technologies and Materials for the Manufacture of Model Gaskets," completed at Transilvania University of Brașov in 2009 under the guidance of Prof. Dr. Eng. Alexandru Constantinescu.

Entitled "Research on the Application of Innovative Technologies in Advanced Materials Engineering," this habilitation thesis consolidates my published scientific results in two main research directions: composite materials and advanced processing technologies.

My scientific and professional achievements lie within the field of Materials Engineering, with a focus on developing composite materials processed using advanced technologies.

This habilitation thesis represents a significant step towards exploring and promoting sustainable solutions for producing composite materials. It aims to conserve natural resources, reduce dependence on raw materials, and lower production costs.

The thesis is structured in four sections, namely: in the first and second parts, the professional and scientific achievements obtained in the last 15 years by the author are presented, in the third part, the career evolution and development plans are detailed, and in the last part, the references used in this work are presented.

Section B, entitled SCIENTIFIC AND PROFESSIONAL ACHIEVEMENTS AND CAREER EVOLUTION AND DEVELOPMENT PLANS, is structured in three subsections, as follows:

B1. Professional Achievements

This chapter briefly summarizes the achievements of the author of the habilitation thesis in the following three directions: studies and experience, scientific and professional achievements and didactic activity.

Throughout this period, my research activities have resulted in the presentation of 12 papers at international conferences, the publication of 35 articles in BDI journals, and 76 ISI articles, with

20 as the first author or corresponding author. I have won four national and international projects through competition and participated in another 11. The impact of my work is reflected in my Hirsch indices: 12 in the ISI database, 13 in Scopus, and 16 in Google Scholar.

Subsection B2 Scientific Achievements is structured in 5 chapters, as follows:

Chapter 1. Modeling of matrices from reinforced resin composite materials, as a function of the thickness and mechanical strength of thin walls – postdoctoral research; In this chapter I present the research carried out between 2010 and 2013, where I studied glass fiber reinforced resin composites and in addition to other achievements (participation in national/international conferences, publication of ISI articles, etc.), I also filed a national patent proposal with number RO128812-A0 and on 30.03.2020 I received the Patent of Invention with number 128812.

Chapter 2. 3D **Assisted Manufacturing of Hybrid Eco-Composite Structures** - Research Contract Competition 2017 "Grants for Young Researchers"; The project proposal aimed to implement and demonstrate a new concept for obtaining eco-composite material structures using a multi-purpose 3D additive technology that involves: a) the development and implementation of a self-healing procedure for the fiber/matrix interface and b) the development of a flexible configuration for the mold for forming new material architectures.

Chapter 3. Solar sintering of parts with controlled cellular morphology architecture made in molds obtained by 3D printing. In this study, solar-powered sintered parts with controlled internal geometry were obtained by using a 3D printed negative and the principles of powder metallurgy. This approach has not been used before and can be considered an innovation in the field, especially due to the proposed configuration of the copper parts, which is difficult to achieve using other technologies.

Chapter 4. Improving the properties of A6 steel 3D printed and nickel-plated parts by solar treatment.

The work plan that was carried out was the following:

- ✓ obtaining metal parts with SLS technology;
- ✓ electrochemical nickel deposition with two different thicknesses [A(100μm±15%) and B(200μm±15%)];
- ✓ surface heat treatment using solar energy at 800°C (±10°C) and 900°C (±10°C) and holding times of 5, 10, 15 and 20 minutes at each temperature;
- ✓ surface heat treatment using solar energy at 800°C (±10°C) and 900°C (±10°C) and holding times of 5, 10, 15 and 20 minutes at each temperature for samples that did not have a deposited Ni layer;
- ✓ electrochemical nickel deposition with two different thicknesses – D(100μm±15%), E(200μm±15%) on the previously mentioned solar treated samples;
- ✓ characterization of the obtained parts: wear resistance, roughness, friction coefficient;

Chapter 5. Ecological composites made using 3D printing techniques to obtain sound-absorbing panels, Financing contract no. 75 / 13.05.2022, code PN-III-P1-1.1-TE-2021-0294.

Within the project, a series of activities and results obtained according to the financing contract TE 75/2022 were proposed and carried out, over a period of 24 months.

After completing all the stages and activities within the project, they were successfully completed in a proportion of 100% and, in terms of the dissemination of the results, the estimated number of both scientific papers in ISI journals (Q1 or Q2) and presentations at international conferences was exceeded.

Within the project, a number of 6 influencing factors were determined, factors that directly influence the sound-absorbing properties in the case of 3D printed panels and a number of 4 factors in the case of composite sound-absorbing panels obtained from recycled materials (cellulose + beeswax + fir resin + horsetail).

In the case of panels obtained directly from CAD models (3D printed), a number of nine panels were highlighted with all the conditions for obtaining them (void configuration, percentage of voids in the volume, material density, 3D printing characteristics, etc.).

The best results obtained are precisely in the case of these eco-composite panels, with a sound absorption coefficient $\alpha = 0.99$, panels that are the subject of national patent application No. 00099/2024 and international patent application PCT/RO2024/000011.