Universitatea *Transilvania* din Braşov

HABILITATION THESIS

SUMMARY

Tailoring the effective properties of hybrid polymer based composite materials

Domain: Mechanical Engineering

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BRAȘOV, 2015

The overall aim of the work is to provide comprehensive means of predicting and characterizing the properties of principal hybrid polymer based composite architectures that can simultaneously yield results of practical utility. This is accomplished by comparing, whenever possible, the theoretical predictions for the effective properties to available experimental data.

The present work is divided into two parts. Part I deals with the author's scientific achievements that enabled to characterize quantitatively the main effective properties of self-developed hybrid polymer based composite architectures and different theoretical and computer-simulation methods used for comparison. Part II describes the author's scientific backgrounds in connection with the approached subject and identifies future directions for professional and academic evolution and development.

The introductory chapter in Part I was reserved to the state-of-the-art in the subject intended to be covered with the main body of the habilitation thesis. This was done on purpose to illustrate the importance of developed subject that is under continuous evolution and that expanded after herein author's first contributions. It is noteworthy that significant advances have been made recently in the quantitative characterization of hybrid composite materials of any type both theoretically and experimentally.

The general objectives were underlined and concise delivered to give the reader a preview of the concepts that will be discussed specifically in the subsequent chapters. Indirectly, they point toward one of the main aims of this work, namely to provide a direction for systematically analysis of hybrid polymer based composite materials.

Chapter 2 was dedicated to the brief presentation of individual materials' selection, manufacturing issues, details on hybrid microstructures and finally, some practical information on experimental devices and settings considered. Practically, reproducibility issue of the experimental data processing can be potentially addressed through sharing these particular information results.

Chapter 3 provides a review of the theoretical models used deploying a multi-step homogenization scheme, particular developed by the herein author, to apply for individual combinations and effective property under consideration. These theoretical models were selected due to their ability to describe the 'details of the microstructures' (i.e. constitutive volume fractions, orientations, sizes, shapes, spatial distributions and surface areas of interfaces, etc.) and ability to encompass particular information that can be ascertained in practice.

In the light of above, particular concerns was given to those structure/property relations that can be easily understood by apprentices, unaccustomed researchers on engineering field and finally, to materials' designers bounded by cost and time to perform measures on their mechanical applications for all possible combinations, phase properties and microstructures aimed to be developed.

Chapter 4 extensively approaches the effective mechanical, dynamical, linear thermal expansion and thermo- and electrical conductivities of particular hybrid polymer based composites developed. These effective material properties were retrieved by subjecting the various hybrid composite specimens to extreme environmental temperature range to address the sustainability issue and some practical implementation considerations.

Over the entire sections of this chapter was followed the same formalism, including: section's objectives, applied standards used to run the exploratory tests, particular and representative experimental curves, details on the retrieved values, predicted over recovered data comparison relevant for the effective property vs. micro-structural dependence description and analysis.

Structural design and applications emerging from this cannot be sough strictly to comply or use solely the mechanical properties. In the mechanical engineering field, the applications are driven by a multitude of influencing factors whose cross-dependencies can be regarded to the seemingly different effective properties considered here.

Moreover, the experimental data can be effectively translated to practice and have important implications for the optimal design of composites. Space limitations and overcome the settled objectives do not enable us to treat, in any detail, the cost and error minimization topics identified as the major issues that benefit from the herein retrieved information.

General conclusions presented in Chapter 5 provide the merits of the theoretical predictions, the main reasons behind the effective property's behavior during the conditions imposed within the experimental runs and a unified framework to study a variety of different hybrid composite architectures with their tailored effective properties.

Additionally, these can be regarded as an ex-ante foundation and conditionality for further hybrid polymer based composited architectures tailored from natural reinforcements and matrices under the so called ‘green' composites material category. In the light of previous mentioned and with respect to the effective properties of hybrid polymer based composites, further directions for scientific research were identified and briefly described at the beginning of Part II of the work.

Specific citation to the literature used, both own published contributions between 2006 to 2015 and other sources have been kindly provided at the end of Part II as references. These were used in correlation to the section's subject and can be easily identified and suitable checked. It is noteworthy that few sections contain unpublished work of undersigned used to clarify some aspects related to the effective property under discussion and provided to enable readers to comprehend the ongoing discussions and related conclusions.