

Design and synthesis of bio-sourced benzoxazine based materials from natural phenols: toward environmentally friendly and application-oriented composites and hybrid systems

PhD. Student Mădălina-Ioana NECOLAU (PISCANU)

PhD. Advisor Prof. Dr. Ing. Horia IOVU

Abstract

The PhD thesis outlines an integrated approach to the development of advanced, sustainable polymeric materials, addressing current demands for high performance and environmental protection in the context of fossil resource depletion. The research focuses on polybenzoxazines, a class of thermosetting materials with well-established applications in advanced technological fields, and explores their potential to be synthesized from renewable natural sources. In this regard, the thesis investigates the use of natural phenolic derivatives, such as sesamol, vanillin, and eugenol, in combination with polyethyleneimine, for the design, synthesis, and characterization of sustainable benzoxazine structures, highlighting their influence on the final properties of the obtained materials.

The main objective of the research was the development of advanced bio-polybenzoxazine formulations with complex molecular architectures and tunable properties, suitable for meeting the requirements of high-performance applications. Within this framework, the versatility of benzoxazine monomers bearing free amino functional groups was explored for the development of innovative composites and hybrid networks. Chemical interactions between bio-benzoxazines and graphene oxide, as well as carbon fibers, were investigated in order to obtain lightweight composite materials intended for electromagnetic interference shielding applications.

In addition, the thesis addresses the development of hybrid networks based on benzoxazine monomers, epoxidized linseed oil, and thiol derivatives. The influence of thiol type and concentration on the thermal, mechanical, nanomechanical, and network properties was systematically studied using advanced characterization techniques. Through the conducted research, this doctoral thesis makes a significant contribution to the current state of knowledge in the field of polybenzoxazine resins derived from natural sources and highlights their potential for bridging the gap between laboratory-scale research and industrial implementation.