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Chemical Sciences

PhD Thesis

CARBON NANOTUBES AND GRAPHENE
AT THE INTERFACE AND IN THE 3D-NETWORK:
PHYSICOCHEMICAL MODIFICATIONS FOR
FUNCTIONAL SYSTEMS

Nanorurki węglowe i grafen na granicy faz
oraz w sieci trójwymiarowej: modyfikacje
fizykochemiczne dla układów funkcjonalnych

Supervisor: Prof. Sławomir Boncel, DSc PhD Eng.

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ABSTRACT OF DOCTORAL DISSERTATION

Carbon Nanotubes And Graphene At The Interface And In The 3D-Network: Physicochemical Modifications For Functional Systems

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Graphene and carbon nanotubes (CNTs) are among the most promising nanomaterials due to their exceptional mechanical strength, electrical and thermal conductivity. However, their effective implementation in macroscale systems remains challenging due to poor dispersibility, incompatibility with polar media, and difficulties with scalable processing. Overcoming these limitations is essential to bridge the gap between the remarkable intrinsic properties of these nanomaterials and their practical applications.

This dissertation is a study of the design of functional graphene- and CNT-based composites, with an emphasis on sustainable, scalable processing methods. The main objectives included understanding the amphiphilic properties of graphene and CNTs to enable the stabilisation of Pickering emulsions, as well as investigating the influence of CNT morphology, including aspect ratio and crystallinity, on the thermophysical performance of paraffin-based nanocomposites and developing a biomimetic approach for graphene modification to achieve stable aqueous dispersions and electroconductive coatings.

Overall, the research provides new insights into how morphology, surface chemistry, and interfacial interactions govern the macroscopic properties of carbon nanostructure-based systems. The development of sustainable routes and multifunctional composites paves the way for scalable, environmentally responsible applications of graphene and CNTs in modern technologies.