GOLUBEV ARTEM

«New UV-curable alkyd-siloxane film-forming materials»

Abstract

The relevance of the research topic is hereby demonstrated. The relevance of hybrid polymers today is associated with their unique properties, a wide range of applications and potential for solving modern technological and environmental problems. The ongoing advancements in the domain of hybrid polymers have been instrumental in facilitating their integration into diverse industrial sectors, thereby underscoring their significance as a pivotal component in the future of materials science and the chemical industry. Alkyd-siloxane oligomers and polymers are classified as hybrid systems, wherein the alkyd oligomer structure functions as an organic component, while the polyorganosiloxane (-Si-O-Si-) bond serves as an inorganic component. To date, a significant number of studies have been published on the development of alkyd-siloxane film-forming materials used in organic coating technology. However, despite the achievements already realised, the development of hybrid film-forming systems remains a promising avenue of research and innovation. This is due to the introduction of new chemical reactions and innovative synthesis methods, which opens up wide opportunities for the development of materials with improved properties and the expansion of their areas of application. The energy efficiency of photochemical initiation of the curing reaction is a pivotal factor in the relevance of the research topic. UV curing is a process that occurs at a significantly faster rate than traditional curing methods. This reduction in production time and energy costs is a key benefit of UV curing. Furthermore, the work employs a photo-initiated thiol-ene "click" reaction, which is an effective alternative to the classical polymerization of vinyl compounds. It is also noteworthy that contemporary scientific advances have engendered the necessary conditions for the synthesis of hybrid alkyd-siloxane coatings through a hydrothiolation reaction. The extant literature describes methodologies for the production of hybrid coatings based on vegetable oils and organosilicon compounds using a photo-initiated thiol-ene "click" reaction. Furthermore, polymer-analogous transformations involving alkyd

oligomers containing double bonds and thiol-containing compounds are of considerable interest.

The paper also presents the results of a study of a water-emulsion material based on a UV-curable alkyd-siloxane composition. In the contemporary era, there has been a discernible global shift in preference from organosoluble film-forming materials to environmentally sustainable water systems. The development of a water-emulsion material based on an alkyd-siloxane composition will allow the abandonment of toxic organic solvents, thereby emphasising the relevance of the research topic. Furthermore, the development of UV-curable materials necessitates an interdisciplinary approach, encompassing the domains of chemistry and physics of polymers, materials science and coating technology. This contributes to the active development of scientific research and creates the prerequisites for the successful implementation of new knowledge in modern technological processes.

The aim of the dissertation is the development and comprehensive study of new hybrid alkyd-siloxane coatings obtained by the method of photo-initiated thiol-ene "click" reaction based on UV-curable compositions of various compositions. To achieve this goal, the following tasks were solved:

– synthesis and characterization of oligomers for obtaining UV-curable film-forming materials;

– obtaining UV-curable alkyd-siloxane film-forming materials;

– development of a method for obtaining stable aqueous emulsions based on an alkyd-siloxane UV-curable composition;

– study of the regularities of the curing process of alkyd-siloxane materials;

– establishment of correlation dependencies between the structural and chemical characteristics of film-forming materials and the functional properties of hybrid alkyd-siloxane coatings.

Scientific novelty:

The present study constitutes the first documentation of hybrid alkyd-siloxane coatings obtained by means of the thiol-ene click reaction.

The optimal conditions for obtaining a water-emulsion material based on a UV-curable alkyd-siloxane composition have been established.

For the first time, kinetic parameters and diffusion-transport characteristics have been established during the curing process of alkyd-siloxane compositions.

The present study has established the influence of the ratio and chemical nature of the components of UV-curable alkyd-siloxane film-forming materials on the properties of hybrid coatings.

The theoretical and practical significance of the dissertation results is determined by the establishment of kinetic and diffusion patterns of the photocuring process of alkyd-siloxane systems by the thiol-ene "click" reaction, which contributes to the development of fundamental concepts of the structure formation of oligomeric products in the process of forming a three-dimensional cross-linked network of chemical bonds. Theoretical foundations for controlling the structure and properties of coatings by varying the composition of oligomeric precursors have been developed. Recent advancements in the domain of hybrid materials chemistry have been particularly notable for the expansion of scientific knowledge regarding the relationship between the structure of oligomers, their curing conditions, and the physicochemical characteristics of coatings. UV-curable alkyd-siloxane film-forming materials based on organosoluble, aqueous and solvent-free compositions have been developed for the first time. The application of thiol-ene chemistry to alkyd-siloxane systems under photocuring conditions has the potential to create new materials with specified performance characteristics.

The thesis has been submitted for defence as follows:

– Synthesis and characterization of oligomers for obtaining UV-curable alkyd-siloxane film-forming materials;

– Research of curing processes of alkyd-siloxane compositions;

– Hydrophobic, physical-mechanical and protective properties of hybrid alkyd-siloxane coatings.