National Technical University

"Kharkiv Polytechnic Institute"

Technology of Polymer and Composite Materials and Coatings Department

Our Proposal for Cooperation

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Our Fields of Research

We are interested in cooperation in the fields of:

The scientific activities of our department are focused on the research in the field of chemistry and technology of polymer composite materials (PCM), development of cold-hardening mixtures (CHM) for the foundry and also the creation of new types of film –forming substances for paintwork materials (PWM) that provide highly-efficient long-term anticorrosion protection for material facilities of a different function.

The department develops the following scientific areas:

- Creating the new types of ecologically valuable pentose and hexose - based paintwork materials and PCMs using natural annually renewable raw materials.
- Synthesizing new functional monomers, oligomers and cross-linked polymers based on monomers and oligomers.
- Synthesizing modified polyurethanes using no diisocyanates and creating PCM on their basis.
- Synthesizing heterocyclic nitrogen-containing cross-linked polymers.
- Synthesizing oligo-and polyesters that are reactive fire-retardants to create flame-proof fabric materials that cannot be burnt through by metal drops and sparks; those posses high sanitary -&- hygienic properties and are moisture impermeable, steam-tight and air-tight and are nontoxic for the cutaneous covering.

Our Developments

To carry out our investigations, we use new catalytic systems, in particular complex onium catalysts (COC) that exhibit high catalytic activity in epoxide and lacton polymerization reactions.

Based on the natural plant raw materials,in particular furfural, furfuryl alcohol and furfurylglycidyl ether and their derivatives we produce ecologically safe paintwork materials that contain no volatile organic compounds (VOC) and advantageously differ by many physicochemical and physicomechanical parameters.

New monomers and oligomers made of pentoses exhibited high reactivity in thermopolymerization and photopolymerization reactions.

New monomers and oligomers allowed us to create ecologically friendly cold-hardening mixtures (CHM) to replace phenol-formaldehyde-furfurol resins that can be used as casting box fasteners and rods for the foundry. “Know-how” and “hi-tech” have been patented.

Special attention is paid to the research in the field of kinetics and catalysis done to produce cyclocarbonates from monodiepoxide compounds that serve as parent compounds to obtain nonisocyanate polyhydroxyurethanes and PCM on their basis.

Unsaturated organic bromine-containing fire-retardants make textile materials fireproof due to the formation of cross-linked structure during the thermal polymerization and these also retain the thermal screen on the fabric in the form of polyphosphate salts (inorganic fire retardants). The treated fabric is put into the group of flame-proof fabrics according to sanitary and hygienic standards and can be used for the sewing of clothes for fire fighters, welders, flame cutting torch operators, metallurgists and also for domestic purposes.

Our Publications

1. Arnold Karateev New network polymer based on furfurylglycidyl ether/ Arnold Karateev, Andrew Koryagin, Denis Litvinov ent.el. // Chemistry and Chemical technology, 2008, V.2, №1, p 19-26.
2. Karateev A.M., Taranukha Ya.A / New fireproof Composition for textile material // Journal “Scientific Israel-Technological Advantages” (Sita Journal) 2009, v.11, №1, p 80-91.
3. A.M. Karateev, D.A. Litvinov, A.G. Koriagin, O.S. Kalkamanova – Renewable Raw Material Sources and Raw Material Based Polymers // The Way of Science international Scientific journal // 2014, №6 (6), p.15-21.
4. Arnold Karateev, Denis Litvinov, Olesya Kalkamanova // “Nonisocyanate” polyhydroxy urethanes based on the raw material of a plant origin // Chemistry and Chemical technology.-2014, vol.8, №3, p.329-338.
5. A Kalkamanova, D. Litvinov, A.Karateiev, A.Koriagin // Diels-Alder adduct isomerization studies using DSC and PMR methods // Journal “Scientific Israel – Technological Advantages” // 2015, vol. 17, №3, P. 95-101.

Head of project associate prof. Viktor Yu. Kramarenko

Development and investigation of nitrogen-containing heterocyclic polymer networks

Heterocyclic polymers (polyisocynurates, polyoxazolidones, polyimides) are used extensively as high performance materials in a variety industrial sectors due to high heat and chemical resistance and excellent durability. Most properties of such polymers relates to structural features based on molecular design of chains and cross-linking density. Depending on the ratio of these two structural components networks have a wide range of properties.

The aim of the project is development and investigation of nitrogen-containing polymer networks with focus on the effect of composition and controlled cross-linking on the main mechanical, dielectric and protective properties.

Some publications with our collaboration in this area are presented below:

1. Kramarenko V.Yu., Ezquerra T.A., Sics I., Balta-Calleja F.J., Privalko V.P. Influence of cross-linking on the segmental dynamics in model polymer networks // J. Chem. Phys., 113(1), 447-452 (2000) // https://dx.doi.org/10.1063/1.481809

2. Kramarenko V.Yu., Ezquerra T.A., Privalko V.P. Probing the subglass relaxation behaviour in model heterocyclic networks by dielectric spectroscopy // Phys. Rev. E, 64, 051802-1-7 (2001) // https://doi.org/10.1103/PhysRevE.64.051802

3. Kramarenko V. Yu., Ezquerra T., Privalko V.P. Relationships between conductivity and local topology in heterocyclic polymer networks. // Phys. Rev. E, 67, 031801-1-7 (2003) // https://doi.org/10.1103/PhysRevE.67.031801

4. Kramarenko V.Yu., Alig I., Privalko V.P. Structure-property relationships for model heterocyclic polymer networks: effect of network density // J. Macromol. Sci., Phys. – 44, №5, 697-709 (2005) // https://dx.doi.org/10.1080/00222340500251139

Head of project associate prof. Viktor Yu. Kramarenko

Development and investigation of water-based coating materials with improved properties

Problems of protecting the global environment have become key subject in the world nowadays. As a consequence, the application of water dispersions of polymers instead of solvent-borne systems is increase actually in numerous technological applications including coating materials and adhesives. These compositions are regarded to environment-friendly materials due to little content of volatile organic compounds. The main trend of investigation for such materials is connected with improving of special properties and durability.

The aim of the project is receiving of fundamental knowledge of content-property relationships for water-based paints for developing of formulations and prediction of ways for improving of performance and durability of coatings. The decision of this task is realized by wide-range purposive modifying of formulations for investigation of film-formation processes, mechanical and transport properties of the coatings. Our experience in this area is presented in publications:

1. I.M. Kas'yanenko, V.Yu. Kramarenko Determination of internal stresses of coatings based on water-borne coating materials // Visnyk NTU "KhPI", 2015, № 50(1159), pp. 24-32 (*in Ukrainian*) // http://repository.kpi.kharkov.ua/bitstream/KhPI-Press/20376/1/vestnik_KhPI_2015 _50_Kasianenko_Vyznachennia.pdf

2. I.M. Kas'yanenko, V.Yu. Kramarenko The influence of pigment volume concentration on the vapor and liquid water permeability of coatings based on water dispersion paint and varnish materials // Voprosy khimii I khimicheskoy technologii, 2016, vol. 2(106), pp. 68-73 (*in Ukrainian*) http://udhtu.edu.ua/public/userfiles/file/VHHT/2016/2/Kasyanenko.pdf

3. I.M. Kas'yanenko, V.Yu. Kramarenko The influence of pigment volume concentration on film formation and mechanical properties of water-based coatings. 1. Film formation // Mech. Comp. Mater. (*in press*).

4. I.M. Kas'yanenko, V.Yu. Kramarenko The influence of pigment volume concentration on film formation and mechanical properties of water-based coatings. 2. Mechanical properties // Mech. Comp. Mater. (*in press*).