"Development of composites with increased impact resistance based on a modified epoxy urethane binder"

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Abstract The use of epoxy organoplastics in the manufacture of shockproof products, in particular composite helmets, is due to a whole range of valuable properties: high strength and rigidity, low shrinkage during curing, heat resistance, and good technological capabilities.

The disadvantages of epoxy matrices include low crack resistance, low elasticity and impact strength. This leads to delaminating upon impact, which creates obstacles for their use in anti-impact products.

Also an important task is to determine the parameters of the curing process, to identify their correlation with the adhesive properties of the "aramid fiber - epoxy matrix" system, as well as to study the possibility of activating the surface of the aramid fiber to obtain a strong interfacial interaction.

The task of increasing impact resistance can be partially solved by modifying epoxy resins with cyclocarbonate modifiers..

In this case, the decrease in the viscosity of the modified composition can be compensated by the use of active diluents.

The choice of an active diluent for an epoxyurethane binder and the creation of composite materials based on a modified binder and aramid fibers with increased impact resistance is an urgent task.

The main goal of the present work was to develop composite materials based on an epoxy oligomer and a cyclocarbonate modifier using diglycidyl ethers. In accordance with this, research was carried out in the dissertation work in the following areas: studying the effect of active diluents of various nature on the kinetics of the curing process of epoxy-polyurethane binders and the structure of the resulting polymer network; development of organoplastics with improved adhesive properties based on modified binders.

The main tasks were:

1. To investigate the effect of diglycidyl ethers on the curing process of the binder, consisting of epoxy resin, cyclocarbonate modifier Laprolat 803; to determine the physico-mechanical characteristics and the glass transition temperature of the compositions in the case of the use of amine hardeners PEPA and TETA.

2. Determine the effect of pre-impregnation of the reinforcing filler (aramid fibers and aramid fabric) with an active diluent on the adhesive characteristics of the cured layered composite material.

3. To develop a technology for obtaining composite materials reinforced with aramid fibers based on a modified epoxy binder, including one filled with HDPE microgranules.

4. Investigate the deformation-strength properties of the obtained hardened composite materials and the resistance to delamination upon impact.

5. Determine the prospects for further development of new functional epoxy composites.

Scientific novelty. Methods have been developed to control the process of crosslinking epoxy oligomers using a cyclocarbonate modifier with the help of active diluents, which made it possible to obtain binders with improved adhesive characteristics to aramid fibers. It has been established that during the curing of the epoxy-polyurethane binder, it is possible to control the rheokinetics of the process and the adhesive characteristics of the resulting network polymers. It was revealed that the introduction of polyethylene microgranules into the interlayer space of organoplastics contributes to the dissipation of impact energy and an increase in impact strength when using a modified epoxy binder. It has been shown that the sorption of low molecular weight active diluents by aramid fibers promotes better migration of the molecular chains of the epoxy-polyurethane binder into the interfibrillar regions and leads to high physicomechanical and adhesive characteristics of the composite.

The theoretical and practical significance of the work.

The influence of various reactive diluents based on diglycidyl ethers on the physico-mechanical and adhesive properties of epoxy compositions has been studied. It has been shown that changing the curing kinetics by introducing reactive diluents can promote the formation of supramolecular formations and increase the adhesive strength to fibers without a significant decrease in the rigidity and strength of the composite. Composite materials have been developed using epoxy oligomers and a cyclocarbonate modifier of the Laprolat brand based on aramid fabrics and polyethylene microgranules, which have increased resistance to delamination and impact strength. A prepreg technology has been developed for producing epoxy materials reinforced with aramid fabric with polyethylene microgranules for use in shockproof products.

Defense Provisions.

1. Development of composite materials with enhanced physical and chemical properties based on epoxy oligomers modified with oligooxypropylenetriol tricyclocarbonate (Laprolate 803) and diglycidyl ethers (Laproxide BD, Laproxide E181);

2. Study of the rheokinetics of the formation of network structures of epoxy polymers using the thermographic method and the effect of reactive diluents on these processes;

3. Development of technology for obtaining epoxy materials reinforced with aramid fabric with polyethylene microgranules for use in shockproof products.