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# STUDY OF THE STABILITY OF TITANIUM DIOXIDE AQUEOUS SUSPENSION IN THE DEVELOPMENT OF FLAME RETARDANT POLYMER COMPOSITIONS

I.V. HOROKHOV, V.M. LAVRIK, T.S. ASAULYUK, N.S. SKALOZUBOVA
Kherson National Technical University

Concerns about the toxicity of fire retardants commonly used in the processing of textile materials have directed researchers towards creating more environmentally friendly compositions and finding effective solutions for fire protection technologies of fabrics. Among the directions for slowing down combustion processes, the introduction of nanoparticles into flame retardant finishing compositions as thermophysical additives is promising. [1].

The addition of nanoparticles reduces the flammability of polymers due to a decrease in the rate of heat release, an increase in the time of ignition, and an ability to self-extinguish. The mechanisms of such protection include physical barrier effects and catalytic processes that can modify the degradation of polymers and form charred protective layers reinforced by nanoparticles. The inherent properties of nanoparticles are dependent on dispersion and chemical modifications to improve compatibility with polymers.

Nanoparticles of metal compounds showed good results in reducing flammability, since these substances are resistant to temperatures up to 1000ºC (hydroxides, carbon nanotubes, etc.) or decompose at temperatures below 400–500ºC (hydroxides, salts). Metal oxides are also able to catalyze coke formation processes and form a protective layer on the surface of a burning polymer [2]. The most studied metal oxides include titanium dioxide, which in addition to thermal properties has a number of defining characteristics: non-toxicity, good electrical, chemical, thermal and photocatalytic properties.

In the textile industry, the nanomaterials are most often dispersed in multicomponent water systems. This can potentially lead to physicochemical changes in properties. For example, the state of agglomeration and surface charge are important characteristics of dispersions. During dispersion of nanoparticles in aqueous solutions, surface ionization and adsorption of cations or anions leads to the formation of a surface charge and the formation of an electric potential between the surface of particles and a volume of the dispersion medium.

Depending on the measurement technique, the surface charge can be represented by the surface charge density (potentiometric titration) or the zeta potential (electrokinetic method). In the work, the stability of an aqueous suspension of titanium dioxide was evaluated based on measurements of the zeta potential using electrophoretic mobility. As a rule, in order to achieve a stable dispersion, the necessary value of the zeta potential should be below -30 mV or above 30 mV, i.e. in the range of $-30\ mV > \zeta > 30\ mV$.

Agglomeration of nanoparticles in an aqueous system can be controlled by the hydrodynamic diameter of the dispersion. In the classical theory of stability of dispersed systems of Deryagin – Landau – Fairway – Overbek, the agglomeration of nanoparticles is determined by the sum of the electrostatic repulsive forces (the interaction of the double electric layer surrounding each particle) and the attractive force. An increase in the surface charge of particles (zeta potential) can increase the electrostatic repulsive force, prevent agglomeration and, therefore, reduce the hydrodynamic size of the dispersion.

The zeta potential of the aqueous suspension of nanosized titanium dioxide with concentration of 0.02 wt% depending on pH was measured by introducing a small amount of the suspension into the cells of Malvern Instruments Technical Note MRK 654-01 (Malvern, England) at room temperature and in the pH range from 2 to 10. Previously the suspension was stirred for 20 minutes on a magnetic stirrer. To improve the result, the suspension of titanium dioxide was subjected to 15 minutes of ultrasonic treatment. A graph describing the effect of the pH of solution on the zeta potential of titanium dioxide nanoparticles is in Fig. 1.

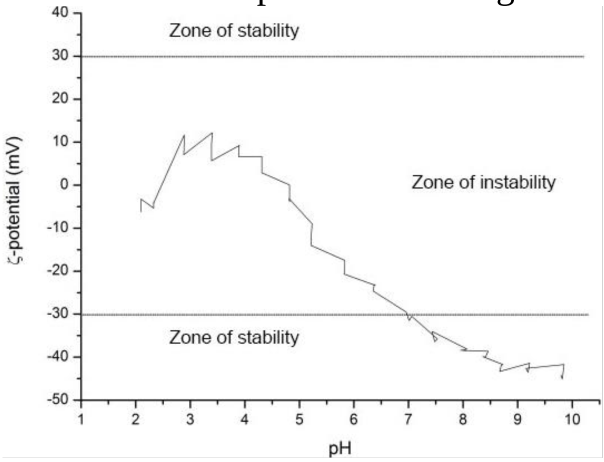


**Fig. 1. Dependence of the zeta potential of titanium dioxide nanoparticles on the pH of a medium**

According to the results of measuring the electrokinetic properties, it was found that at the pH of 7 to 10, the suspension of titanium dioxide is stable because it has a significant negative zeta potential (from -30 mV to -45 mV).

At the pH values from 2 to 7, the zeta potential is in the instability zone (from 10 mV to -30 mV). As a result, the attractive forces can prevail over the repulsive forces, that leading to the aggregation of titanium dioxide nanoparticles.

Thus, in order to create a fire retardant nanocomposite coating on textile materials, the pH of film-forming polymers must be above 7, which is a favorable medium for titanium dioxide dispersion.

## References

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