AL-FARABI KAZAKH NATIONAL UNIVERSITY

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**CHEMICAL TECHNOLOGY OF GLASS**

for the students of the specialty

5В072000 – Chemical technology of inorganic substances

Textbook

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The textbook presents the theoretical foundations of glass production, its physico- chemical properties, discusses in detail the basic technological stages of obtaining glassware. The textbook contains laboratory works for determining some characteristics of the glass. In order to improve the learning of theoretical material, and also for the control of the students’ knowledge, there are test questions in the textbook. The textbook can be used during the study of the subjects "Chemical technology of silicate materials", "Chemical technology of glass and ceramics".

The textbook is designed for the students enrolled in the chemical-technological specialties, and can also be used by the lecturers and staff working in the field of producing silicate materials.

# 1 Glassy State

## 1.1 Definition of the glass. General properties of the substances in the glassy state

There are two types of the solid state - crystalline and amorphous. The glassy state of a substance – is a special case of the solid amorphous state, the characteristics of which are the lack of a strictly ordered structure, isotropy of the properties, and also the absence of a definite melting point temperature.

The glassy state is metastable, it does not meet the conditions of thermodynamic equilibrium. The transition from the glassy state to crystalline - is exothermic process which under normal conditions does not occur spontaneously. This is due to the very high viscosity in the solid state and low mobility of the structural elements.

In the literature there are several definitions of the glass. The generally accepted one is the following: the glass is all amorphous solids obtained by supercooling the melt irrespective of the chemical composition and the temperature range of freezing point and which have mechanical properties of solids as a result of a gradual increase of the viscosity; the transition process from the liquid state to glassy must be reversible.

This definition is based on the single principle of obtaining the glass - from the melt by its supercooling without crystallization. However, there are some ways of producing glassy substances without prior obtaining a melt, for example from aqueous solutions, gels, under vapor condensation or neutron irradiation of the crystalline compounds. In this regard, the presented wording does not fully correspond to the properties of glass, although it still reflects the most typical signs of a glassy state.

The glassy state in comparison with crystalline is thermodynamically unstable. Therefore, the increase of the mobility of the particles in the glass when heating causes crystallization. At the same time, the process of the transition from a liquid state to glassy and vice versa is not accompanied by the significant changes in the nature of the spatial arrangement of the particles, and there is no sharp sudden change of the properties. All glassy substances have the following common properties:

1. The excess of internal energy reserve compared to the internal energy reserve of the respective substance in a crystalline state. The glasses are obtained by melt supercooling. They are the systems that are in a metastable nonequilibrium state. Therefore, due to the extremely high viscosity, the glasses can be in a metastable state for a long time without any signs of the transition to steady, crystalline state. However, due to excessive internal energy reserve, crystallization of glassy substance is accompanied with the heat generation and is an exothermic process.