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ELECTRIC PROPERTIES OF IONIC THERMOTROPIC LIQUID CRYSTALS

This work presents the results of studies of the electric properties of samples of oriented ionic thermotropic liquid crystals (ITLC) of cobalt decanoate, lead decanoate, and their binary mixture. It is found that all studied samples in the temperature range, where a liquid crystal exists, are weak electrolytes. All investigated compounds are characterized by an anisotropy of bulk conductivity caused by the ordering of molecules. The values of electric conductivity, activation energy, charge mobility, and concentration are estimated.

K e y w o r d s: ionic thermotropic liquid crystals, cobalt alkanoate, lead alcanoate, binary mixture, conductivity, anisotropy of conductivity.

1. Introduction

The research of new promising materials for the engineering and the development of devices for data processing and storage is one of the important directions of modern science. Due to the recent trends, the great attention is paid to the studies of untraditional types of liquid crystals (LC) such as organosilicon compounds [1, 2], Schiff base metal complexes [3, 4], and ITLC of alkanoic acid homologs. The latter are characterized by the presence of intrinsic ionic conductivity [5–7]. The unconventional properties of these materials open up new possibilities for various practical uses [8–10]. Ionic liquid crystals (ILC) of metal alcanoates form an insufficiently explored group of liquid crystals [11, 12], which have a number of advantages comparing to traditional molecular liquid crystals. Most uni- and divalent metal alkanoates form ionic liquid crystals of smectic A type, while melting [13]. These compounds are promising for the development of systems for the recording of information due to their intrinsic ionic conductivity, high solubility, good thermal stability, and ability to form mesomorphic smectic glasses [8, 9, 14]. Despite this, there are negligible amount of data [3, 5, 15–16] on the electrical properties of oriented samples of ITLC, charge mobility, and charge concentration in such compounds.

2. Materials and Cell Preparation

2.1. Materials

The types of chemical compounds mentioned below were used for studies of transport properties: 1) individual compound of cobalt decanoate $(C_9H_{19}COO^-)_2Co^{2+}$ (temperature interval of the mesophase: 378–573 K); 2) individual compound of lead decanoate $(C_9H_{19}COO^-)_2Pb^{2+}$ (temperature interval of the mesophase: 353–388 K); 2) binary system – $(C_9H_{19}COO^-)_2Co^{+2}\,|C_9H_{19}COO^-Pb^{+2}$ (90 : 10 mol.%, temperature interval of the mesophase: 373–423 K).

Metal decanoates $(C_9H_{19}COO)_2M$ were prepared by the metathesis method by adding a saturated aqueous solution of a divalent metal nitrate to a methanolic solution of sodium decanoate. The salts were several times recrystallized from hot toluene and dried in a vacuum drier at 323 K for 24 h. The binary mixtures were prepared by melting the preweighed components in the argon atmosphere and then recrys-