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A. V. Gridyakina

CONDUCTIVITY OF COMPOSITES OF THERMOTROPIC IONIC LIQUID CRYSTALS

Institute of Information and Diagnostic Systems, National Aviation University, Kyiv, Ukraine
E-mail: morhin@ukr.net

Abstract*—*This work presents the studies of the transport properties of samples of oriented binary composite of cobalt decanoate with lead decanoate. Found that samples of the mixture at the temperature range of liquid crystal existence are weak electrolytes, which have anisotropy of bulk conductivity caused by the ordering of molecules. The values of mobility and charge concentration were estimated.

Index Terms—Ionic thermotropic liquid crystals; cobalt alkanoate; lead alcanoate; binary mixture; conductivity; anisotropy of conductivity.

I. INTRODUCTION

The research of new perspective materials for engineering and development of data processing and storage devices is one of the important directions of modern science elaboration.

Because of this, in recent years, much attention is paid to the study of composites and multicomponent mixtures of liquid crystals (LC). Mixtures of ionic liquid crystals attract particular interest. Unusual properties of these materials offer new opportunities for a variety of practical applications. Great importance have study the transport properties of these materials.

II. ANALYSIS OF INVESTIGATIONS AND PUBLICATIONS

Metal alkanoates $C_nH_{2n+1}COOM$ form thermotropic ionic liquid crystals (TILC) during their melt. One of the main features of TILC is intrinsic ionic conductivity. Despite this, there are almost no literature data [1]–[3] on the electrical properties of binary mixtures of TILC, charge mobility and charge concentration in such compounds.

Thus, the aim of the present work were:

– investigation of conductivity of binary mixture of cobalt and lead decanoate TILC;

– study of charge carriers mobility in TILC and evaluation of their concentration.

III. METHODS AND OBJECTS OF RESEARCH

The investigation of electric properties was conducted for samples of cobalt decanoate $(C_9H_{19}COO^-)_2Co^{2+}$ (T_{melt} = 82 °C, T_{clar}>300 °C), lead decanoate $(C_9H_{19}COO^-)_2Pb^{2+}$ (T_{melt} = 87 °C, T_{clar} = 114 °C) and binary mixture Pb^{2+}, $Co^{2+}|(C_9H_{19}COO^-)_2$ (90:10 mol. %, T_{melt} = 83 °C, T_{clar}=115 °C).

The bulk electrical conductivity of all samples was determined by oscilloscopic method [4]–[7]. The triangular voltage signal had peak value of 0,10–0,25 V. The frequency dependence of bulk resistance for all examined samples was investigated in temperature range of LC formation. It was found, that in the frequency range $10^4 < f < 10^6$ Hz measured resistance almost does not depend on frequency. This indicates a uniform volume distribution of the voltage applied to the sample. Low values of alternating voltage applied to the samples made electrochemical processes on electrodes impossible.

Small-angle X-ray studies [8] have shown that LC phase of investigated materials belongs to Smectic A type. The molecules are packed in a bilayers formed by alkyl chains, among which are cation-anion interlayer – cations of cobalt (or lead) and the oxygen atoms of carboxyl groups with negative charge.

The cells with metal electrodes (Ni, Cu) were used for investigation of electrical conductivity of smectic TILC. The samples are characterized by strict homeotropic alignment [8], which allowed to investigate anisotropy of conductivity of TILC. Therefore, the electrodes in cells were placed relatively glass substrates either as a sandwich (Fig. 1a) or planar (Fig. 1b). The cell was filled with material by capillary method during its melting. To prevent the "absorption" of water in the sample cell edges were sealed with glue. In the case of a cell with planar arrangement of electrodes they specified the cell thickness. The thickness of cells with sandwich electrodes was specified by glass spacers. In both cases thickness of the sample was 85 microns.

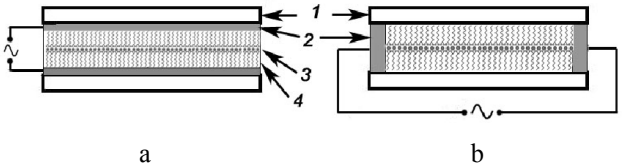

Fig. 1. Types of LC cells for studies of electrical properties: a is the cell with sandwich electrodes; b is the cell with planar arrangement of electrodes: *1* is a glass substrates; *2* is a Ni or Cu electrodes; *3* is a cation-anion interlayer; *4* is a alkyl chains of molecules