Molecular films of cholesterylmyristate were obtained between gallium electrodes by deposition of surface-active molecules from a solution in decane. The dependence of the volt-ampere characteristics on the concentration of cholesterylmyristate in solution and on the temperature was studied. It was likewise shown that the refractive index increases while the rotation of the polarization plane decreases with a growth in the concentration of molecules in the solution.

Molecular films of surface-active substances between metallic electrodes may be obtained according to the method described in [1, 2]. Unlike the papers mentioned, we used liquid gallium as the metallic electrodes. The cholesterylmyristate was dissolved in a nonpolar and neutral solvent—decane—with a resistivity above $10^{11}$ $\Omega \cdot $cm. Liquid-gallium electrodes were placed into this solution, and polar molecules of cholesterylmyristate were deposited on their surface. If the concentration of molecules on the solution was sufficient, then a continuous film of dissolved substance was formed. As the electrodes were brought closer together, the solvent was expelled. The gap was reduced until the deposited molecular films touched. Thus, the thickness of the film obtained was approximately equal to double the thickness of the layer absorbed on the metal. If the concentration is such that only a monomolecular layer is formed on the metal, then the film will be bimolecular. For a lower concentration of molecules in the solution, a continuous film is not formed, and the metallic electrodes may merge. For high concentrations, the thickness of the films formed will be greater than the thickness of the bimolecular layer. Thus, an investigation of the dependence of the properties on the concentration of molecules in the solution also means an investigation of the dependence of the properties on film thickness.

1. Properties of a Solution of Cholesterylmyristate in Decane

In order to perform the investigations, solutions were prepared having the following cholesterylmyristate concentrations: $1 \cdot 10^{-3}$, $5 \cdot 10^{-3}$, $1 \cdot 10^{-2}$, $5 \cdot 10^{-2}$, $1.5 \cdot 10^{-1}$, 0.25, 0.4, 0.5 mole/liter. The addition of cholesterylmyristate changes the properties of the solution. The rotation angle of the polarization plane of the light changes noticeably as a result of passage through the solution (Fig. 1). For a change in cholesterylmyristate concentration from $1 \cdot 10^{-3}$ to 0.5 mole/liter, the specific angle of rotation $[\alpha]$ changes by approximately a factor of three (from 0.6 to 0.17 deg/mole $\cdot$ liter$^{-1}$ $\cdot$ mm). Such a strong dependence is evidently associated with the fact that cholesterylmyristate molecules are optically active.

The refractive index of the solution likewise depends on the concentration of the dissolved molecules. Cholesterylmyristate increases the optical density of the solution (Fig. 1, curve n) by approximately half a percent; for a change in concentration from $1 \cdot 10^{-3}$ to 0.5 mole/liter, the refractive index increases from 1.409 to 1.416.

In the investigated range of concentrations, the specific rotation may be approximated by the following formula:
2. Dependence of the Volt-Ampere Characteristic on Concentration

The volt-ampere characteristics were recorded on a PO-5122 polarograph. Since the two electrodes had identical properties, the characteristics turned out to be symmetrical; therefore, data is given for only one polarity.

An increase in the concentration of molecules in the solution leads to significant growth of the film resistance (Fig. 2). For a change in cholesterylmyristate concentration from $5 \cdot 10^{-3}$ to $4 \cdot 10^{-1}$ mole/liter, the current for a direct voltage across the film decreases according to a law close to a logarithmic law (Fig. 3). For example, for a voltage $U = 0.69$ V,

$$I = 1.2 \cdot 10^{-4} \log 2C,$$

where $I$ is the current in amperes, and $C$ is the concentration in mole/liter.

At lower concentrations, the current increases with decreasing concentration; this may be evidence of the fact that the film is becoming porous. The thickness of the film in the pores may be substantially smaller, since the limiting factor of adsorbed molecules is not present.

A change in the dependence of the current on the concentration of molecules in the solution also occurs at concentrations exceeding $C = 5 \cdot 10^{-1}$ mole/liter. It is possible that this is related to the fact that at such concentrations the film thickness practically ceases to depend on the concentration of the molecules. A layer of molecules is formed on the electrodes which is such that it may be retained by the forces of interaction between the molecules and the metal surface.

3. Temperature Dependence of the Volt-Ampere Characteristics

Figure 4 displays a family of volt-ampere characteristics of cholesterylmyristate films, which were obtained for concentrations of molecules in the solution equal to $1 \cdot 10^{-3}$ mole/liter. At room temperature, the volt-ampere characteristic is described by the formula

$$I = I_0 \exp(V/V_0)$$

over a wide range of currents; here $I_0 = 4.7 \cdot 10^{-6}$ A, $V_0 = 0.114$ V.

At lower temperatures in the region of fairly large biases the volt-ampere characteristic is governed by the same law, the quantity $V_0$ being practically constant in the temperature range from +20 to −40°C. At the same time, the value of $I_0$ in this same temperature interval decreases by approximately one order of magnitude (Table 1).

However, the scatter of these quantities, especially of the values of current, is fairly large for establishing the law governing the variation with temperature.

<table>
<thead>
<tr>
<th>TABLE 1</th>
</tr>
</thead>
<tbody>
<tr>
<td>T, °C</td>
</tr>
<tr>
<td>$V_0$, V</td>
</tr>
<tr>
<td>$\mu A$</td>
</tr>
</tbody>
</table>