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# Studies of Mixed Monolayers of Lecithin and Organometallic Compounds

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**Abstract**

Compression isotherms of mixed monomolecular layers at water-air interface, formed of lecithin (DPPC) and an organometallic compound ($Me_3PbCl$, $Me_3SnCl$, $Et_3PbCl$, $Et_3SnCl$) at various molar fractions (x = 0.0, 0.2, 0.4, 0.6, 0.8, 1.0) were studied. It was found that compression isotherms of the pure organometallic compounds (x = 1.0), in the range of mean molecular areas of 1.0 $nm^2$ and ca. 0.15 $nm^2$, did not show any practical increase in surface pressure. The isobaric relationship between mean molecular areas and molar fraction of an organometallic modifier are linear for most of the pressures chosen, which follows from analysis of the experimental isotherms obtained and demonstrates the ideal behaviour of the system under study. All the compounds studied form nearly ideally-behaving systems with lecithin. Presumably, the effects observed may be the result of molecular aggregation on the water phase surface, which in a mixed monolayer may lead to separation of the phases: organometallic compound - lecithin.

**Keywords:** Organoleads, organotins, lecithin, mixed monolayers.

## Introduction

The practical importance of studies on the interaction between organic compounds of tin and lead and living organisms follows from the fact that the compounds occur in our environment and exert a marked effect on living cells and higher organisms. Organotin compounds have wide application as biocices, heat stabilizers of polyvinyl chloride, catalysis for production of urethanes or for esterification, as treatment for some infections [1, 2].

Organolead compounds, mainly tetraethyllead compounds, have been used in large quantities as antiknock petrol additives. Triphenyllead salts have been introduced, among others, as pesticides having a similar biocidal action as tin compound and others [5, 6, 7]. Organotin and organolead compound are toxic to humans, animals, plants and cells [8, 9, 10, 11 ,12, 13].

Studies on the cellular and molecular level indicate that the compounds are membrane active, i e. they act as membrane toxicant [10], exhibit hemolytic action [11, 12, 13, 14, 15] and modify the function of membrane channels [16, 17]. It was also found that the compounds may influence the lipid phase of membrane [18]. From this point of view, the study of thermodynamic properties of lecithin monolayers modified with the compounds may furnish additional information on their interaction with the lipid phase of membrane.

## Materials and Methods

### Chemicals

Lecithin, 1,2-Dihexadecanoyl-*sn*-glycero-3-phosphocholine, (DPPC) came from the SIGMA Chemical Co.

Modifiers: chlorides of trimethyllead, trimethyltin, triethyllead and triethyltin were obtained from ALFA Chemical Co.

### Surface Pressure Versus Mean Molecular Area Isotherms

Surface pressure vs. mean molecular area isotherms were measured for mixed monolayers composed of lecithin and trimethyllead (or trimethyltin) at the molar fractions of organometal: 0.0 (pure lecithin), 0.2, 0.4, 0.6, 0.8 and 1.0 (pure organometal).

The isotherms were run in a rectangular trough with useful dimensions of 280 mm x 82 mm x 10 mm equipped with a Langmuir balance.

Bidistilled water was used as the subphase. Spreading solutions of lecithin, or trimethyllead (trimethyltin), or a mixture of both were prepared as follows: first lecithin and investigated compounds were disolved separately in a chloroform-methanol mixture (8/2, volume/volume). The two solutions were then mixed to give the required molar fraction of organolead (or organotin) compound.

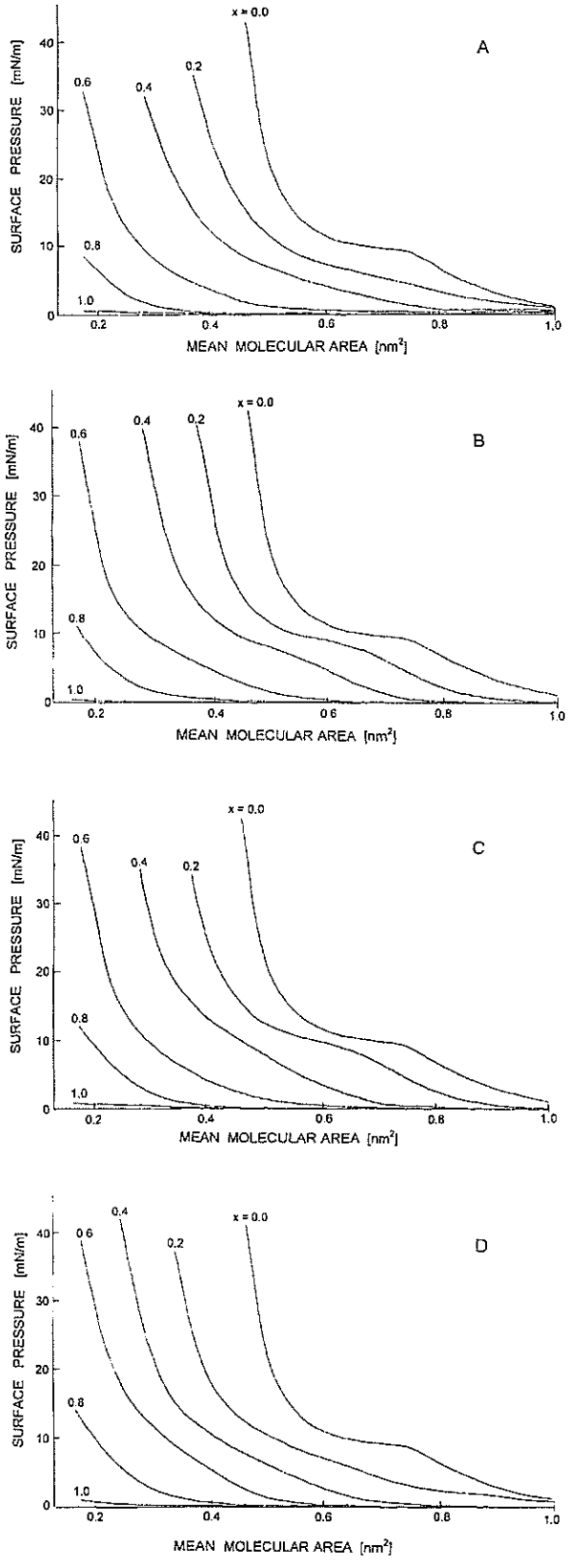



Fig.1. Compression isotherms for two-component mixed monolayers, formed of lecithin (DPPC) and one of the four organometallic compounds studied (a: $Me_3PbCl$, b: $Me_3SnCl$, c: $Et_3PbCl$, d: $Et_3SnCl$). Each of the curves is an averaged isotherm, obtained from at least 5 independent experimental curves.

The monolayer was allowed to stabilize for 20 min before compression. In all monolayer experiments the initial mean molecular area was 1 $nm^2$/molecule, the rate of compression was 0.108 $nm^2$/molecule per min. Experiments were performed at room temperature (20-25)°C.

The analog measurement signals (corresponds to monolayer area and surface pressure) were digitally converted with an A/D conversion card (ADVANTECH Co., model PCL 812 PG, PC-LabDAS Data Acquisition Software PCLS-700) and saved on hard disk.

The data (signals measured vs. time) were transferred to a spreadsheet in which surface pressure as functions of mean molecular area were calculated. The final elaboration of the isotherms as functions of mean molecular area per molecule and molar fractions of modifiers (organolead or organotin) and the creation of isobars was performed under MATHEMATICA v.2.21 package.

## Results and Discussion

Figure 1 (a-d) presents compression isotherms for two-component mixed monolayers, formed of lecithin (DPPC) and one of the four organometallic compounds studied ($Me_3PbCl$, $Me_3SnCl$, $Et_3PbCl$, $Et_3SnCl$). Each of the curves is an averaged isotherm, obtained from at least 5 independent experimental curves.

The results obtained allow to note that:

1. Pure organometallic compounds when compressed to the mean molecular area of about 0.15 $nm^2$ exhibit a relatively small increase in surface pressure, which was less than 2 mN/m (Fig. 1 a-d, isotherms for molar ratios x = 1.0).

2. Mixed monolayers when compressed in the range of molecular areas 1.0 - 0.15 $nm^2$ do not exhibit the phase transition expected for lecithin in the range 0.8 - 0.6 $nm^2$.

Fig. 2 a-d presents the results of interpolation (using 3rd order polynomial) of the functions $\Pi(A)$ and $\Pi(x)$ for the respective compounds. The surface obtained shows how the surface pressure $\Pi$ depends on the two variables: mean molecular area A and molar fraction x. From the results obtained it follows that for each of the compounds studied the surface pressure decreases with increasing molar fraction.

The ability of the modifiers studied to mix with lecithin can be determined from the dependence of lecithin molecular area on modifier molar fraction at constant pressure. A linear course of such dependence indicates at ideal behaviour of the monolayer, i.e. ideal mixing of its components or ideal (and complete) separation of the phases.

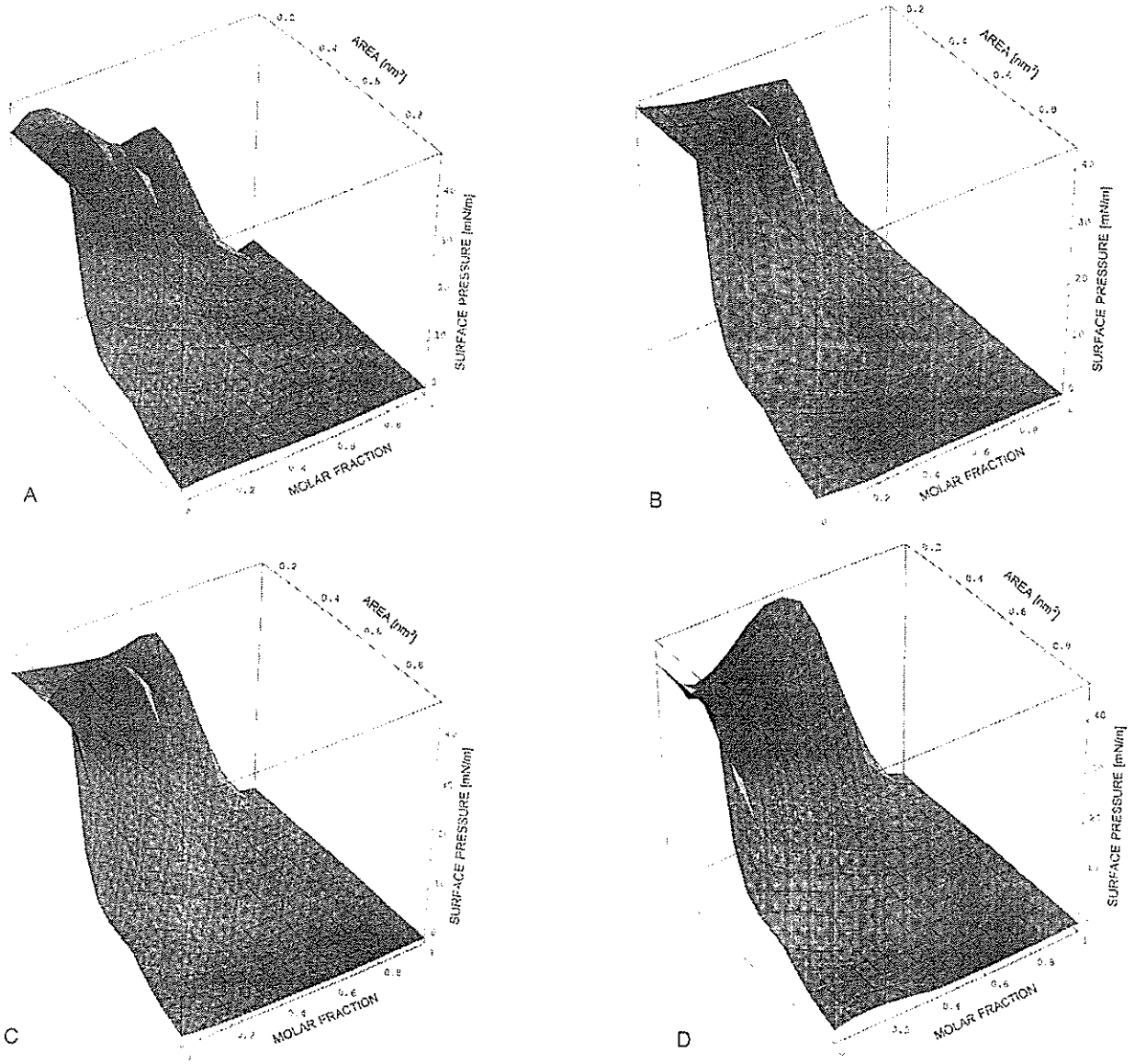



Fig. 2. Dependence of surface pressure of the DPPC-organometal mixed monolayer on mean molecular area and molar fraction of modifier (a: $Me_3PbCl$, b: $Me_3SnCl$, c: $Et_3PbCl$, d: $Et_3SnCl$). The surface $\Pi(A,x)$ was obtained by interpolating, with a 3rd order polynomial, the relation between $\Pi(A)_{x=const}$ and $\Pi(x)_{A=const}$, found experimentally for the molar fractions x = 0.0, 0.2, 0.4, 0.6, 0.8, 1.0.

Fig. 3a-d presents the dependence of mean molecular areas on molar fraction of modifier, for selected surface pressures (i.e. the dependence $A(x)_\Pi$ = const, obtained from intersection of the function $\Pi(A,x)$ and surfaces $\Pi$ = const).

For a majority of the pressures molecular area depends almost linearly on monolayer composition (greater deviations from linearity one can observe for high surface pressures, in the range of molar fractions 0.4 to 0.8, for three compounds but triethyltin).

Linearity of the dependence $A(x)_\Pi$ = const may suggest both ideal mixing of the two monolayer components and the existence of a heterogenic system, i.e. phase separation in monolayer region. In view of the fact that pure organometallic compounds do not yield compression isotherms, the second possibility looks more probable. The more so, as chemical investigation of the subphase did not reveal any organometallic compounds in it during monolayer compression. Thus, if the organometallic compounds do not go from the surface to the water subphase and do not change the character of compression isotherms, most probable seems to be the formation of aggregates of organometallic compounds in the vicinity of the lipid monolayer.

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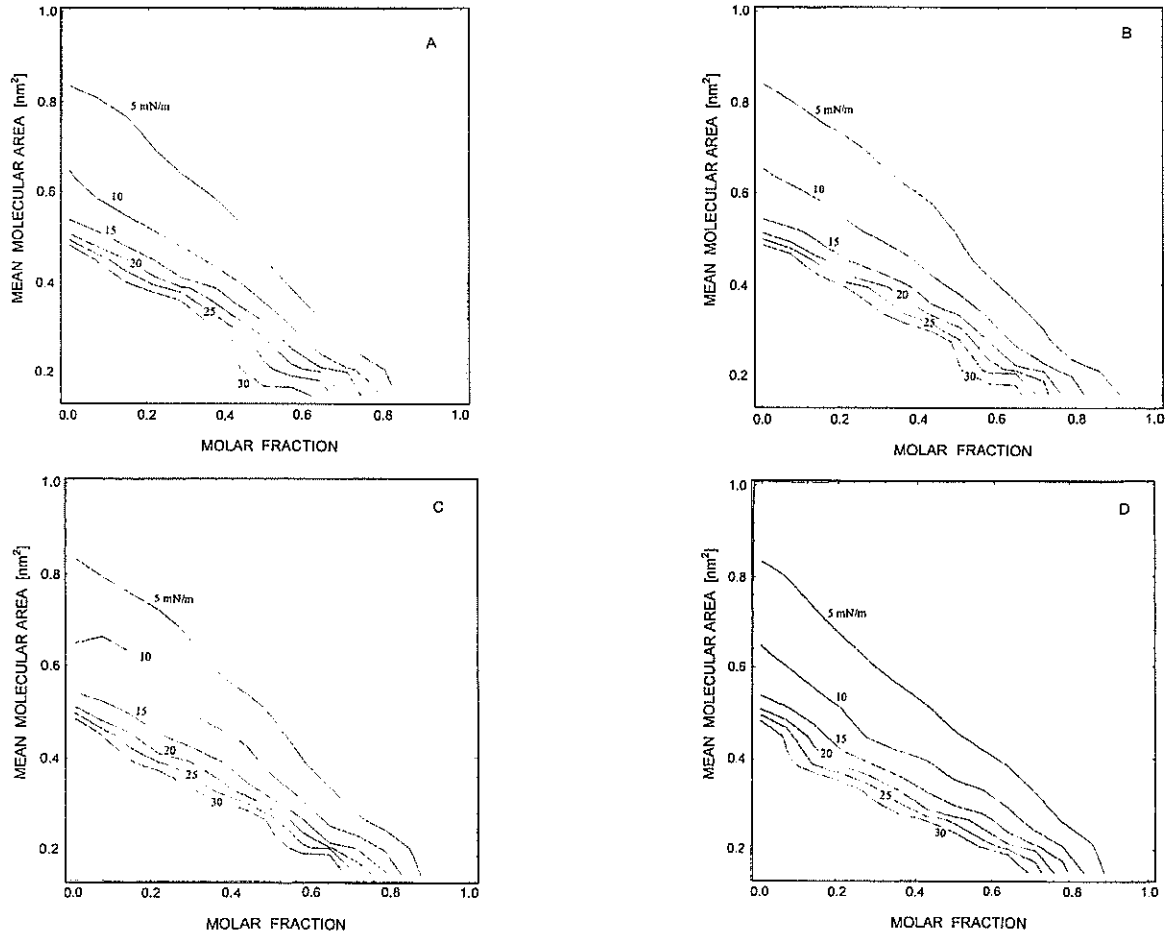




Fig. 3. Dependence of mean molecular area, A, of the DPPC-organometal mixed monolayer on molar fraction of modifier (a: $Me_3PbCl$, b: $Me_3SnCl$, c: $Et_3PbCl$, d: $Et_3SnCl$) for the surface pressures: 5, 10, 15, 20, 25, 30 mN/m. The curves A(x) $\Pi$=const shown were obtained as intersection between $\Pi(A,x)$ and $\Pi$ = const.