Photoelectron Attenuation Lengths

Using

Langmuir-Blodgett Films

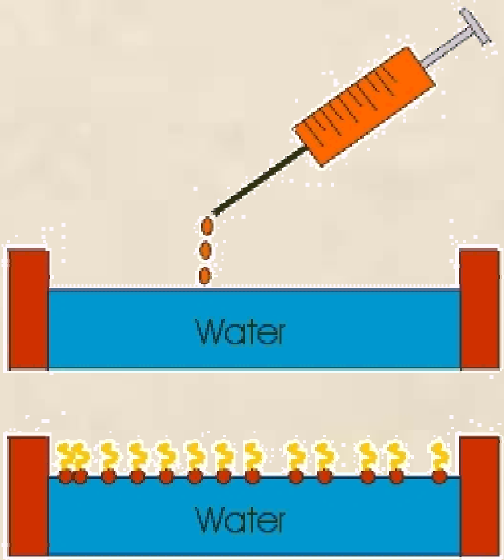
Contents

Introduction to Langmuir-Blodgett Films

When an insoluble organic material is introduced to an aqueous surface, it disperses across the surface.

Preparation of LB Films

1.



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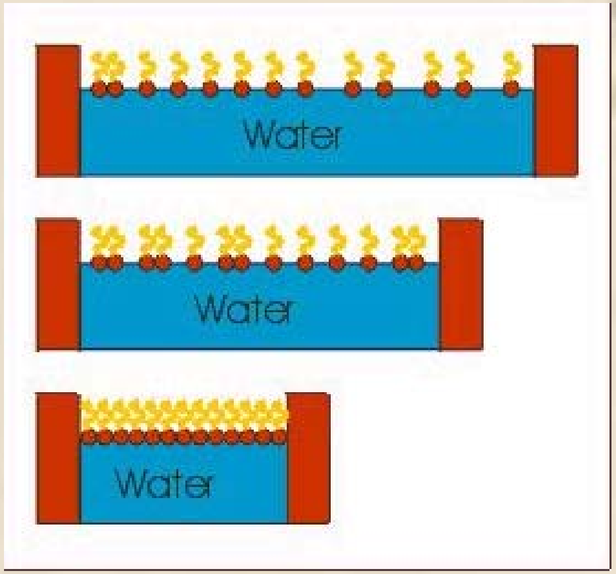

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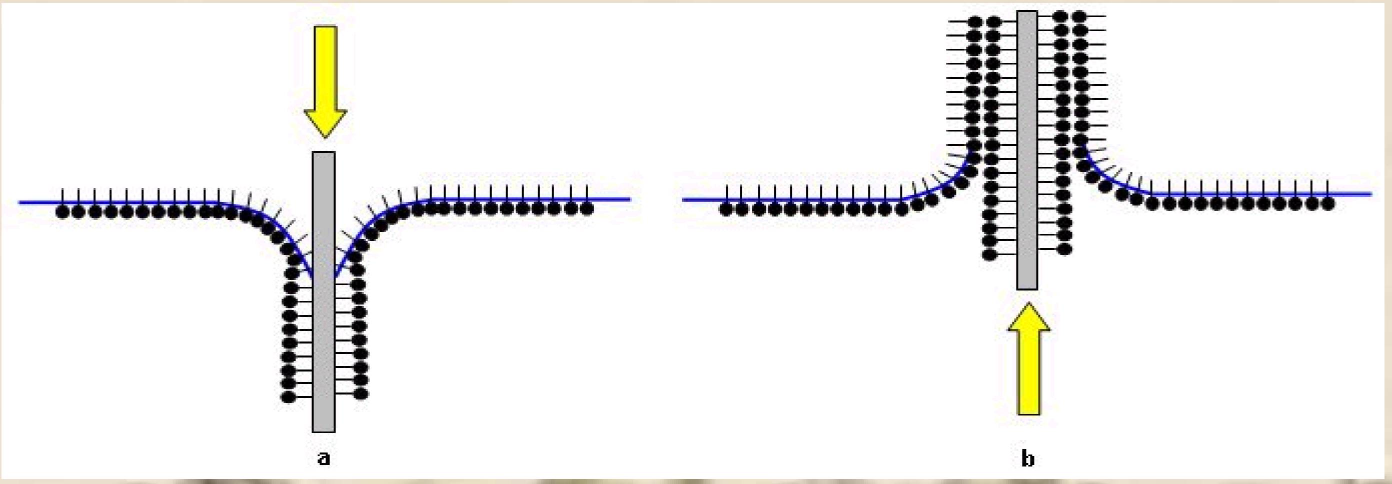
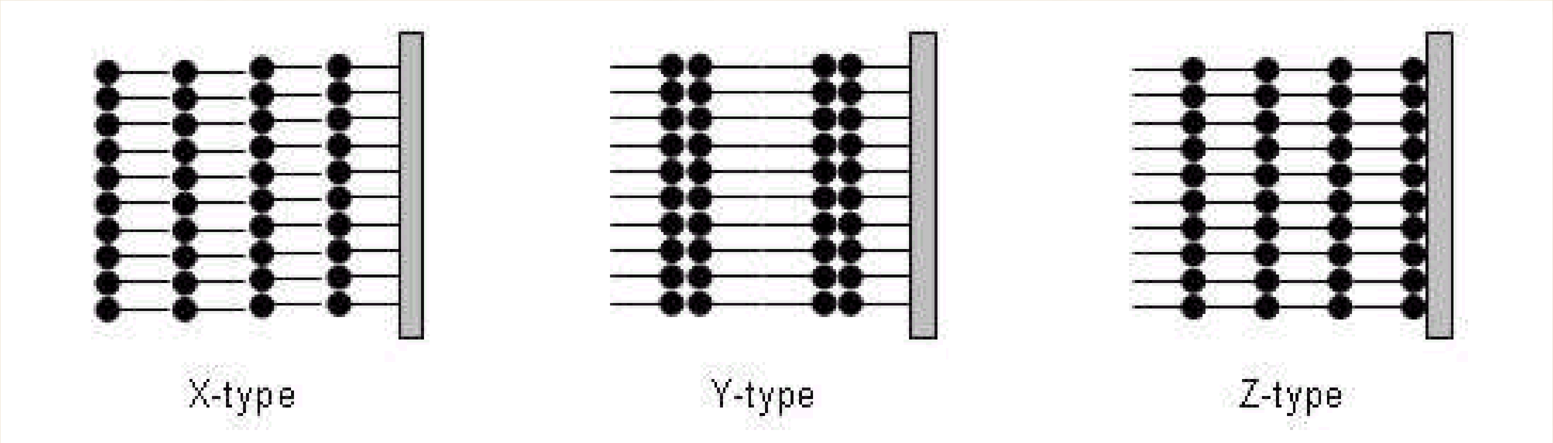
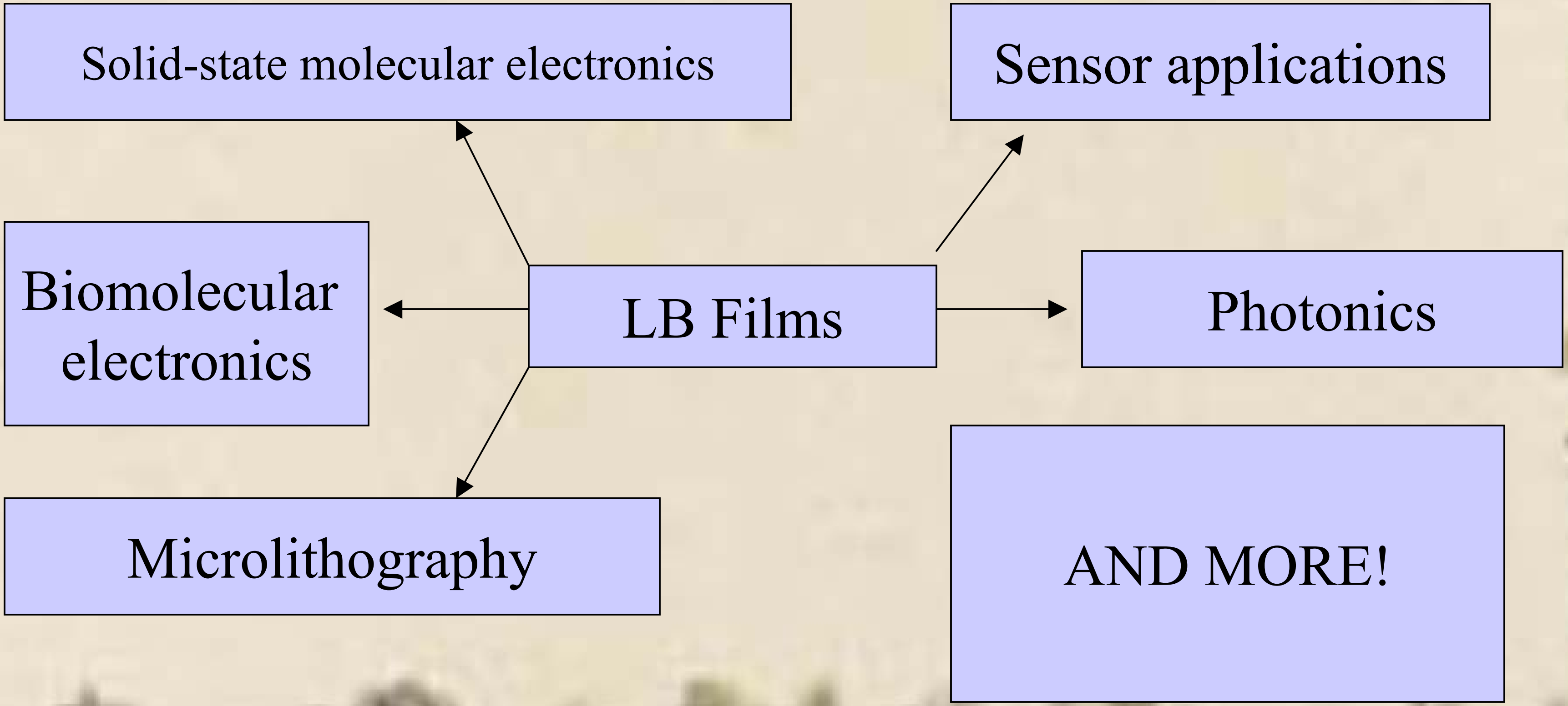



X-type
Y-type
Z-type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LB Films
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AND MORE!

Attenuation Lengths

* The reduction in level of a quantity as a function of a characteristic parameter.

* For unconfined radiation from a point source, the attenuation is inversely proportional to the square of the distance from the source.

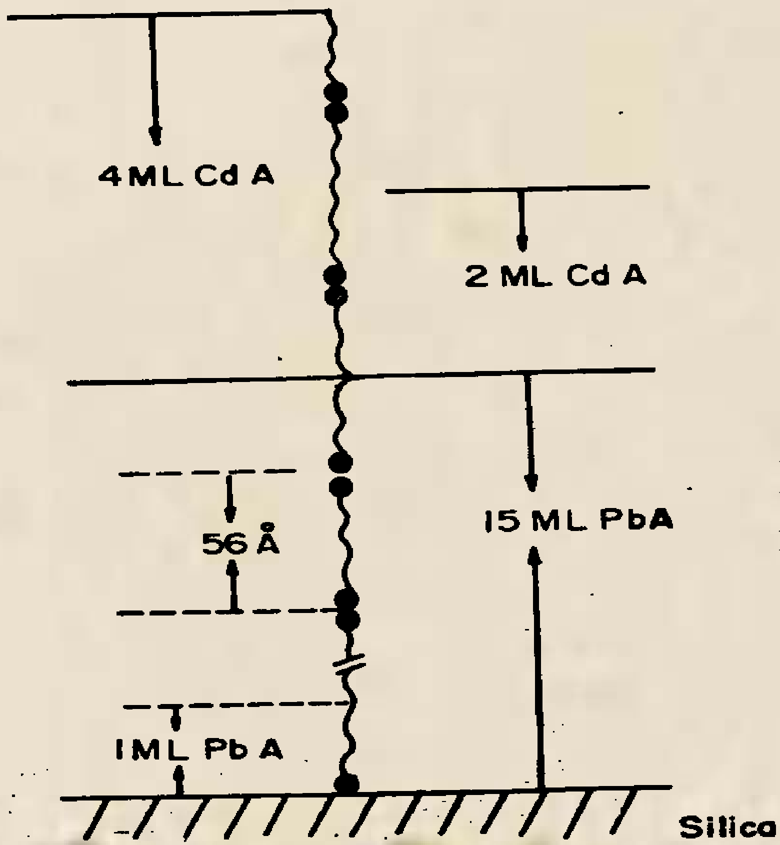
* So from the measure of the attenuation lengths is useful in characterisation of the surface

* For electron in solids, the attenuation lengths can be estimated by variation of x-ray photoelectron intensity with electron take-off angle (ETOA).

Cadmium Arachidate Experiment

✓ Films of 2 and 4 monolayers of Cadmium Arachidate (CdA) is deposited on 15 monolayers of PbA.

✓ The films are transferred to UHV chamber after drying.

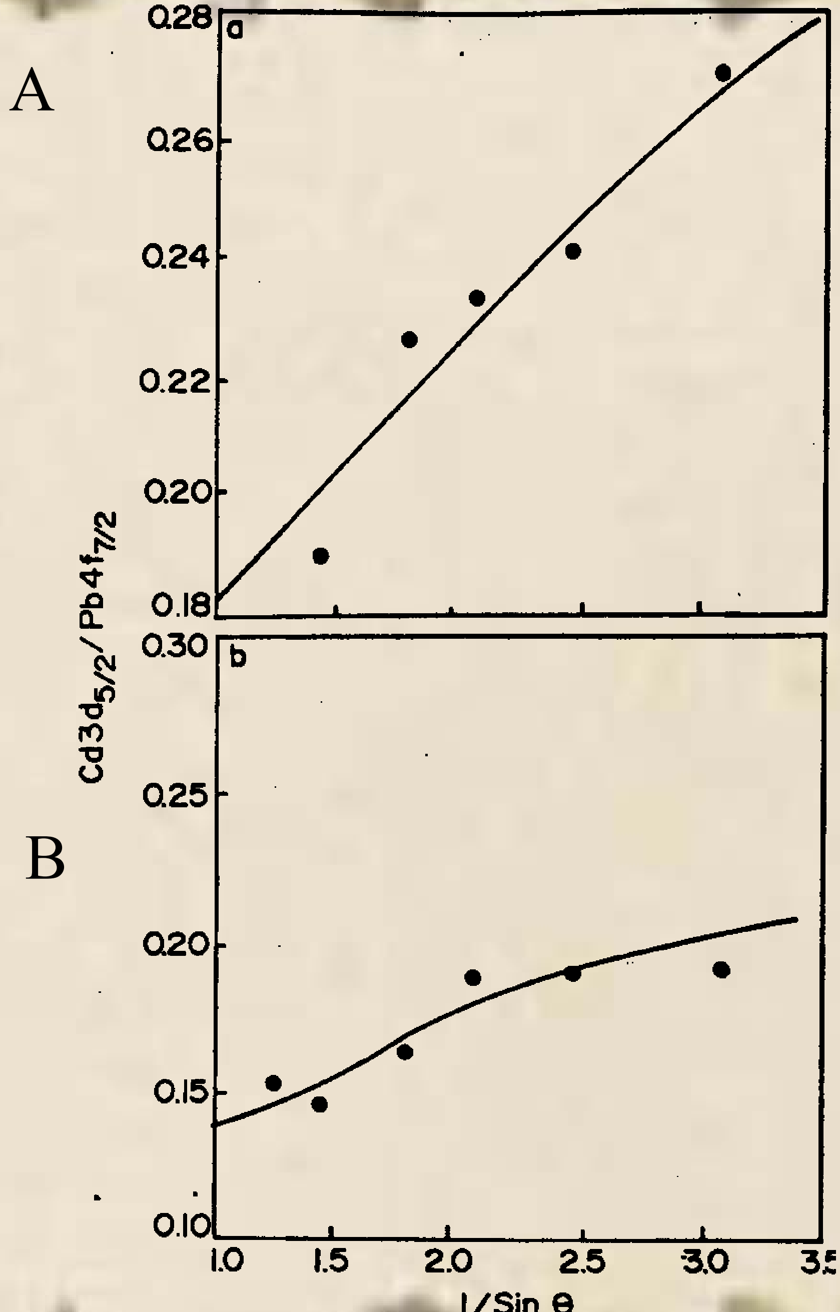


Schematic Diagram of 2 and 4 monolayer CdA LB film on 15 monolayer PbA

The x-ray flux has to be kept at minimum.

The ETOA varies from 15^0 to 55^0.

The variation of Lead $4f_{7/2}$, Oxygen $1s$ and Cadmium $3d_{5/2}$ is recorded.

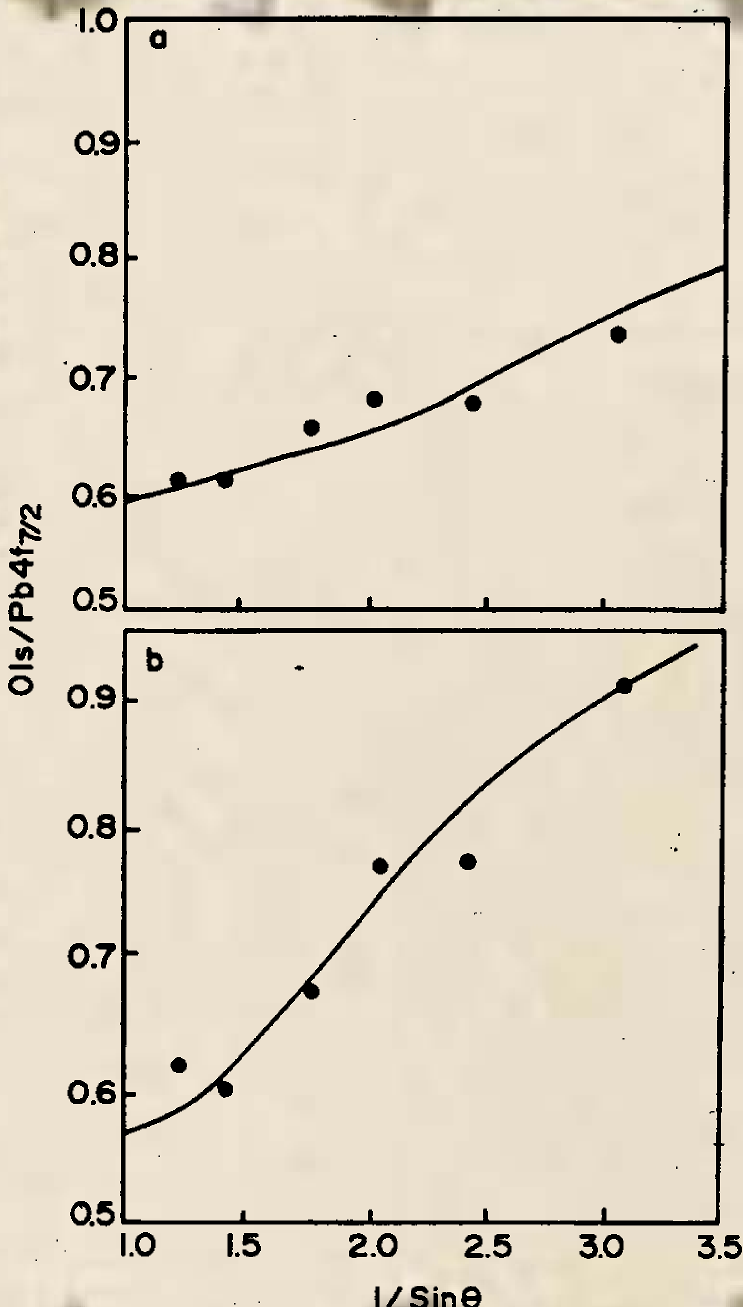


Cd $3d_{5/2}$ to Pb $4f_{7/2}$ for

(A) 2 ML CdA on PbA

(B) 4 ML CdA on PbA

As a function of 1/sinΘ.



O 1*s* to Pb 4$f_{7/2}$ for

(A) 2 ML CdA on PbA

(B) 4 ML CdA on PbA

As a function of 1/sinΘ.

Discrete layer model

The x-ray photoemitted electron flux of energy E attenuated by an overlayer of thickness *t* having a takeoff angle θ is given by

$$I(E,\theta,t) \propto D(\theta,E)\cdot n_E \cdot \sigma_E \cdot \exp(-t/\lambda \sin\theta)$$

where D is an energy and angle dependent spectrometer response

n_e is the number density of atoms at source

σ_e is the ionization cross section

Λ is the electron attenuation length in the overlayer.

The intensity of the lead signal is given by

$$I_{\mathrm{Pb}} = a[(1-\gamma) + \gamma \exp(-nt/\lambda \sin\theta)]$$

where n is the number of monolayers of CdA of thickness t each, Λ is the AL of the electrons in CdA and γ is the surface coverage

The signal intensities were expressed as ratios.

$$I_{\mathrm{Cd}}/I_{\mathrm{Pb}} = a \exp(-28/\lambda \sin\theta)/[0.01 + 0.99 \exp(-3t/93 \sin\theta)],$$

$$I_{\mathrm{O}}/I_{\mathrm{Pb}} = a \exp(-28/\lambda \sin\theta)\{\exp(-16\times 28/\lambda \sin\theta) + 2$$
$$+ 2\exp(-56/\lambda \sin\theta)[1-\exp(-7\times 56/\lambda \sin\theta)]/$$
$$[1-\exp(-56/\lambda \sin\theta)]\}/[0.01 + 0.99 \exp(-3t/93 \sin\theta)].$$

4 ML CdA/PbA:

$$I_{\mathrm{Cd}}/I_{\mathrm{Pb}} = a[\exp(-84/\lambda \sin\theta) + \exp(-28/\lambda \sin\theta)]/[0.01 + 0.99 \exp(-5t/109 \sin\theta)],$$

$$I_{\mathrm{O}}/I_{\mathrm{Pb}} = a \exp(-28/\lambda \sin\theta)\{\exp(-18\times 28/\lambda \sin\theta) + 2$$
$$+ 2\exp(-56/\lambda \sin\theta)[1-\exp(-8\times 56/\lambda \sin\theta)]/$$
$$[1-\exp(-56/\lambda \sin\theta)]\}/[0.01 + 0.99 \exp(-5t/109\lambda \sin\theta)].$$

AL data (in A^o) for electrons in CdA in the energy range 950 –1350 eV

	Pb $4f_{7/2}$	Cd $3d_{5/2}$	O $1s$
KE (eV)	1350	1081	955
2 ML CdA AL (Å)	93 (118)	42 (81)	45 (75)
4 ML CdA AL (Å)	109	39	48

Conclusion

This method allows for determination of ALs of electrons phototemitted from the overlayer also.

AL for a wide Kinetic Energy Range from measurements of the XPS intensity variation with ETOA in LB films can be done.

References

- Murali Sastry, P. Ganguly, S. Badrinarayanan, A.B. Mandale, S.R.Sainkar, D.V.Paranjape, K.R.Patil and S.K.Chaudary, J.Chem.Phys., **95**, 8631 - 8635 (1991).
- Tamas Marek, Csaba Szeles, Karoly Suvegh, Eva Kiss, Attila Vertes and Kelvin G. Lynn, Langmuir, **15**, 8189 - 8196 (1999)