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LB Multilayers and Superlattice Films of Erbium Fatty Acid Salts

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LB Multilayers and Superlattice Films of Erbium Fatty Acid Salts

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Multilayers of Y-type bilayers of pure and mixed erbium palmitate(EP), nonadecanate(EN) and behenate(EB) on CaF_2 substrates were prepared by conventional Langmuir-Blodgett (LB) method. It is demonstrated that two systems composed of alternating bilayer of different fatty acid salts are unidimensional superlattices. These LB films were characterized by means of x-ray photoelectronic Spectrometry (XPS), FTIR and x-ray diffraction (XRD) measurements.

Keywords: superlattice; Langmuir-Blodgett multilayers; erbium salts

INTRODUCTION

A superlattice structure can be produced by alternately depositing two different organic amphiphilic compounds onto solid surfaces using LB technique [1, 2]. These films have many potential applications such as molecular electronic devices[2] and x-ray based devices[3]. According to the space arrangement of the repeating units in the superlattices, they are classified into three types: unidimensional (1D)[1, 2], two-dimensional (2D)[4, 5]

and three dimensional (3D)[5] superlattices. X-ray diffraction (XRD) is a powerful analytical tool for demonstrating the superlattice structure of the thin solid films[1-3]. It can give sharp (001) diffraction peaks in the range of small and intermediary angles [1,2]. So in this paper we use XRD to investigate the quasi-crystalline order of the obtained LB multilayers and superlattice structures.

EXPERIMENTAL

Solution of pure palmitic or nonadecanoic acid in chloroform was spread on 2.5×10^{-5} M $ErCl_3$ aqueous subphase. The monolayer transfer (Y-type) was performed at a constant surface pressure of 30 mN m^{-1} on KSV 5000 system. A BIO-RAD FTS-135 spectrometer was employed for FTIR measurements. XRD was taken with Rigaku D/max RA X-ray diffractometer by Cu-Kα radiation. The XPS spectra were obtained with an ESCALAB MARKII photoelectron spectrometer with an achromatic Al Kα source (1486.6 eV) and the pressure is 4.9×10^{-6} Pa.

RESULTS AND DISCUSSION

XPS measurements confirmed the presence of the element erbium (4d, 169.6eV) in the films (Fig. 1). The experimental and ideal value of Er:C in various LB films are summarized in Table I. The ideal value of Er:C can only be found in the case that every Er^{3+} ion in the film combine with three fatty acid to form triple-chain fatty acid salt. It is seen that all the experimental ratios of Er:C are consistent with their corresponding ideal value within the

experimental errors.

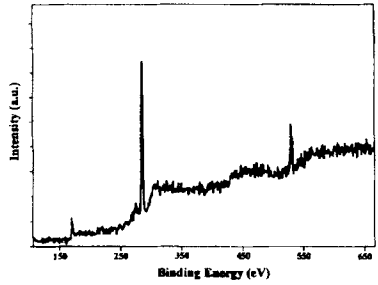

FIGURE 1 XPS spectrum of EN LB multilayers

TABLE I Measured and ideal value of Er:C in five LB films*

LB films	Measured	Ideal
EP_{24}	1 : 48.9	1 : 48
EN_{18}	1 : 58.7	1 : 57
EB_{20}	1 : 69.3	1 : 66
$(EP_2EN_2)_{12}$	1 : 54.1	1 : 52.5
$(EP_2EB_2)_6$	1 : 58.2	1 : 57

*The subscripted number means the number of the monolayers of the fatty acid salt. For example, EP_{24} means 24 monolayers of EP and $(EP_2EN_2)_{12}$ means 12 deposited repeating units of (a bilayer of EP)/(a bilayer of EN).

X-ray diffraction patterns of the monocomponent LB films of EP, EN, EB, their mixed LB films $(EP_2EN_2)_{12}$ and $(EP_2EB_2)_6$ are shown in Fig. 2. The mixed systems exhibit diffraction patterns different from their corresponding monocomponent LB films. The length of repeat unit (d) is calculated according to the Bragg equation ($\sin\theta(h) = \lambda h/2d$, h is the Bragg peak number.). We find that the periodicity of system $(EP_2EN_2)_{12}$ is 10.28nm. This result is approximately equal to the sum of the bilayer spacing of EP(d_{EP} =

4.74nm) and

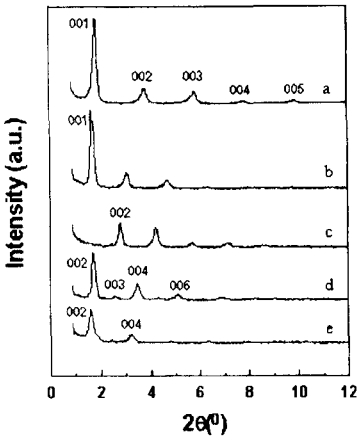

FIGURE 2 XRD spectra of EP(a), EN(b), EB(c), $(EP_2EN_2)_{12}$ (d) and $(EP_2EB_2)_6$ (e) LB films.

EN(d_{EN} = 5.50nm) LB films of 10.24nm. And d of $(EP_2EB_2)_6$ is 11.00nm which is close to the sum of d_{EP} and d_{EB}(6.25nm) of 10.99nm. Within experimental errors, those little differences can be neglected. Fig. 2 only shows the higher order reflections of the lamellar 001 periodicity of the five LB films in the direction of the substrate surface normal. So systems of $(EP_2EN_2)_{12}$ and $(EP_2EB_2)_6$ are unidimensional superlattice structures.

Acknowledgments

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