Growth Mechanism of Lithium Phosporus Oxynitride(Lipon) by Rf Magnetron Sputter

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With advances in fabrication and integration of micro or nano-device, small or micro size power source is also necessary to realize small size electronics. Microbattery (or thin film battery) is a promising micropower source, which is fabricated all solid state. Lipon (Lithium phosporous oxynitride) has recently attracted an attention as a promising candidate as a solid state electrolyte for lithium microbattery [1, 2]. Lipon has good lithium ion conductivity (3.3×10^{-6} S/cm at 25°C) and is stable in contact with lithium metal at large potential window from 0 to 5 V [2].

The Lipon film was deposited on Si substrate by rf magnetron sputter system. The Li_3PO_4 target was sputtered with the rf power of 3 W/cm^2 in a pure N_2. Investigations on the microscopic structural and surface properties of Lipon have been developed using optical microscopy and atomic force microscopy (AFM). *ac* impedance spectroscopy and cycler were used for the electrochemical properties of this film.

Fig. 1 shows optical microscopic images (x 500) which present the evolution of Lipon layer morphology with increasing thickness. For a thickness of 1300Å, the morphology is dominated by many pits and islands. Increasing the layer thickness to 6000Å decreases the number of pits. In contrast, at 9000Å for the Lipon, it is observed that the large size and number of pits are formed on surface. However, increasing the thickness of Lipon layer, the microscopic surface morphology is smoothened and the number of islands is decreased, as shown in Fig. 2. (by AFM image 5 ㎛ ×5 ㎛)

A growth mechanism for Lipon at early stage of the deposition process will be also discussed.

The relation between the growth process, the microstructure and electrochemical properties of Lipon on Si substrate will be presented.

Reference

[1] J. B. Bates, N. J. Dudney, G. R. Gruzalski, R. A. Zuhr, A Choudhury, C. F. Luck, J. D. Robertson, 6th International Meeting on Lithium Battery, J. Power Sources 43 (1993) 103.

[2] X. Yu, J. B. Bates, G. E. Jellison. Jr, F. X. Hert, J. Electrochem. Soc. 144 (1997) 524.

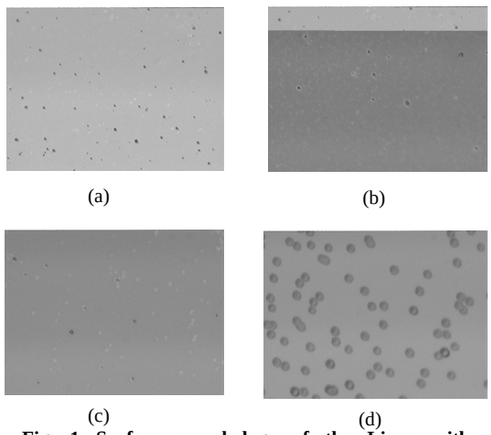

Fig. 1 Surface morphology of the Lipon with thickness (a) 1300 Å(b) 3200 Å(c) 6000 Å(d)9000 Å

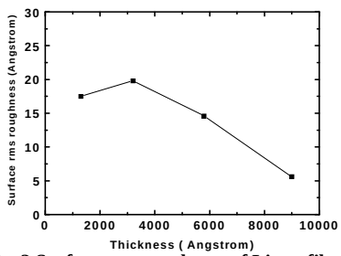

Fig. 2 Surface rms roughness of Lipon film