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The Kinetics of Lithium Transport through the $Li_{1-\delta}CoO_2$ Film Electrode Investigated by Analysis of Current Transient Based upon Fractal Theory

프랙탈 이론에 기초한 전류 추이 곡선의 해석을 통한 $Li_{1-\delta}CoO_2$ 박막 전극내 리튬 이동에 관한 속도론적 연구

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The kinetics of lithium transport through the $Li_{1-\delta}CoO_2$ film electrode was investigated by analysis of current transient based upon fractal theory. For this purpose, 850 nm-thick $LiCoO_2$ films were deposited on such substrates with different roughnesses as a Pt/polished Al_2O_3 and a Pt/unpolished Al_2O_3 by *rf* magnetron sputtering method and then annealed at 700 °C for 4 h in air. From the analysis of the atomic force microscopic images, it was found that the film surfaces showed self-similar scaling properties with different spatial outer cut-offs. Therefore, the film surfaces were characterised quantitatively by the self-similar fractal dimensions ($d_{f,ss}$) determined by triangulation method. From the analysis of the cathodic current transients obtained in a 1 M $LiClO_4$-PC solution, it was recognized that the boundary condition for lithium transport at the surface of the $Li_{1-\delta}CoO_2$ film changes from the 'cell-impedance' controlled boundary condition to the 'real potentiostatic' boundary condition as the lithium injection potential decreases in the single β phase region. However, the cathodic current transients obtained from the film deposited on the Pt/polished Al_2O_3 under the 'real potentiostatic' boundary condition did not follow the generalised Cottrell behaviour with the slope of $-(d_{f,ss}-1)/2$, but simply showed a linear relationship between the logarithm of current and the logarithm of time with the slope of -0.5. This anomalous behaviour of the current transients was discussed in terms of the difference between the temporal outer cur-offs for the surfaces of two films.

References

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