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# An Investigation of the Effect of the Surface Roughness on Lithium Transport through the $Li_{1-\delta}CoO_2$ Film Electrode in terms of Fractal Geometry

# 프랙탈 기하학을 이용한 $Li_{1-\delta}CoO_2$ 박막 전극내 리튬의 이동에 미치는 표면 거칠기의 영향에 관한 연구

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The effect of the surface roughness on lithium transport through the $Li_{1-\delta}CoO_2$ film electrode was investigated in terms of fractal geometry using potentiostatic current transient technique, atomic force microscopy (AFM), image analysis method, and numerical analysis method. For this purpose, 200 nm-thick $LiCoO_2$ films were deposited on the substrates with different surface roughnesses by RF magnetron sputtering method and then annealed at 700 °C for 4 h in air. Surface morphology of the films was examined by using AFM and self-similar fractal dimension of the films was determined by triangulation method. Experimental current transients were obtained from the $Li_{1-\delta}CoO_2$ films in a 1 M $LiClO_4$-PC solution as a function of self-similar fractal dimension. All the experimental current transients showed the behaviour of 'cell-impedance-controlled' lithium transport. The current level increased and the time to reach a new equilibrium decreased with increasing self-similar fractal dimension. From these results, it is suggested that lithium diffusion in the electrode is enhanced by the increase of the surface roughness. In addition, theoretical current transients were calculated from the numerical solution to generalised diffusion equation under both the 'cell-impedance-controlled' constraint at electrolyte/electrode interface and the impermeable constraint at electrode/current collector interface. From the comparison of two current transients experimentally obtained and theoretically calculated, the effect of surface roughness on lithium transport was discussed in terms of fractal geometry in detail.

Reference

1. Y. Dassas and P. Duby, J. Electrochem. Soc., 142 (1995) 4175.