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A Study on the Diffusion-Limited Current Transient of the Self-Affine Fractal RF Sputter-Deposited $LiCoO_2$ Film Electrode Based upon Scaling Property

스케일링 특성에 기초한 RF 스퍼터링법으로 증착된 자기 유연 프랙탈 $LiCoO_2$ 박막 전극의 확산제어 전류추이곡선에 대한 연구

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The diffusion-limited current transient of the self-affine fractal electrode was investigated based upon the scaling property of the electrode by using random walk simulation, atomic force microscopy (AFM) and image analysis methods. For this purpose, the surface morphology of the RF sputter-deposited $LiCoO_2$ film electrode was first examined by using AFM and then the self-affine fractal surfaces with various morphological amplitudes were constructed by magnifying the original AFM image vertically. All the self-affine fractal dimensions of the original and magnified surfaces were estimated to be 2.494 by perimeter-area method. Finally, the diffusion-limited current transients of those self-affine fractal surfaces were theoretically obtained by random walk simulation. The current transients exhibited the more negative power dependence of current on time before the temporal outer cut-off of fractality with increasing morphological amplitude of the self-affine fractal surface, rather than the unique power dependence corresponding to the self-affine fractal dimension of 2.494. This means the self-affine fractal dimension is not always a sufficient condition required for describing the diffusion toward the self-affine fractal surface. In the present work, the anomalous current transients obtained from the self-affine fractal surfaces with various morphological amplitudes were successfully interpreted in terms of the self-similar fractal dimension of the self-affine fractal surface determined by triangulation method.

Reference

1. H.-C. Shin, S.-I. Pyun and J.-Y. Go, submitted to J. Electroanal. Chem. (2002).