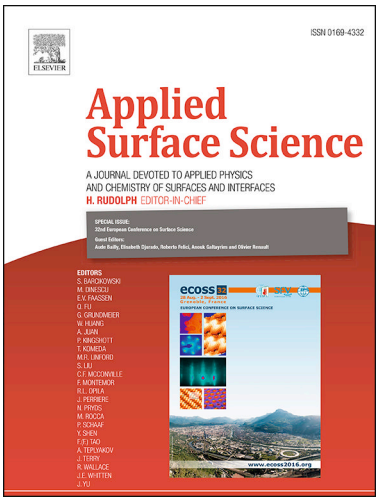
Accepted Manuscript



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PII: S0169-4332(18)31960-3
DOI: https://doi.org/10.1016/j.apsusc.2018.07.062
Reference: APSUSC 39877

To appear in: *Applied Surface Science*

Received Date: 23 April 2018
Accepted Date: 10 July 2018

Please cite this article as: F. Feng, B. Liu, X. Zhang, X. Qian, X. Li, J. Huang, T. Qu, P. Feng, Roughness scaling extraction method for fractal dimension evaluation based on a single morphological image, *Applied Surface Science* (2018), doi: https://doi.org/10.1016/j.apsusc.2018.07.062

Roughness scaling extraction method for fractal dimension evaluation based on a single morphological image

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Abstract

Fractal dimension (D) is an effective parameter to represent the irregularity and fragmental property of a self-affine surface, which is common in physical vapor deposited thin films. D could be evaluated through the scaling performance of surface roughness by using atomic force microscopy (AFM) measurements, but lots of AFM images with different scales (L) are needed. In this study, a roughness scaling extraction (RSE) method was proposed to evaluate D values of a single AFM image, in which the roughness at smaller L was estimated by image segmentation with flatten modification. Firstly, a series of artificial fractal surfaces with ideal dimension (D_i) values ranging from 2.1 to 2.9 were generated through Weierstrass-Mandelbrot (W-M) function, in order to compare RSE method with traditional methods such as box counting method and power spectral density method. The calculated dimension (D_c) by RSE method was much closer to D_i than the other methods, with a mean relative error of only 0.64%. Secondly, RSE method was utilized to deal with real surfaces, which were AFM images of amorphous alumina thin films with L of 1-70 μm. D_c obtained by RSE method based on a single AFM image was also close to the result in our previous study by multi-image analysis at L above 10 μm, while the larger D_c at smaller L was consisted with the actual surface feature. The validity of RSE method and

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