Measuring Fractal Dimension from Micrographs

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The purpose of our work is to overview some fractal dimension computational techniques from micrographs. STM, SEM, AFM, CLSM and TEM micrographs of different physical systems were analyzed. Dynamic scaling parameters and universality classes were investigated in some cases. The fractal dimension and the dynamic scaling parameters of surface topography changes on a larger scale of Cu(110) surface in 10mM HCl electrolyte at different potentials using STM images analysis were computed. Three classes of universality were obtained: first, for the dissolution region, at anodic potentials $\alpha = 0.59$ and $\beta = 0.60$; second, for constant potentials, the temporal scaling parameter $\beta > 0.5$, as in the case of diffusion-bias, and $\alpha \cong 0.5$ which is an argument that in the system correlated noise is important; third, at cathodic potentials, $\alpha = 0.62$ and $\beta = 0.5$, defining a new universality class for surface restructuring, random deposition with correlated noise. An *in situ* time-series STM images of Pd deposition on Au(110) were used to compute dynamic parameters. Also box-counting method was used to compute fractal dimension of images produced by thresholding. The fractal analysis of the CSLM-images of GaAs(100) surface has been carried out by dint of conversion of the grey level of each pixel in height. For computing the fractal dimension of GaAs surfaces, we chose two of the routines proposed for characterization of the fractal surfaces: the height correlation function method and the variable length scale analysis. The variable length scale method is more suitable for higher scaling range than the correlation function method because of the necessity to have enough points in an interval $\varepsilon \times \varepsilon$ to compute rms deviation $R_{q\varepsilon}$, averaged over n_ε, meaning that ε must be high enough for a good statistic. The variable length scale analyses of the GaAs(100) surface, clean and treated with Na_2S and $(NH_4)_2S$, yields better results, by extending the scale range to higher values and giving information concerning the fractal behavior on a larger scale domain. Also, AFM images of GaAs(100) were analyzed. The importance of cut-offs limits is revealed by comparing results from AFM and CLSM images. SEM images of $La_{1-x}S_{rx}MnO_3$ samples were computed using height correlation function method and variable scale method. Scanning electron micrographs of pure and doped lanthanum manganites reveal that the

samples have fine particles with a small tendency of agglomerates formation with different shapes and high porosity. All $La_{1-x}S_{rx}MnO_3$ (x=0-0.3) samples present the crystallite size in 37-43 nm range and high surface area values. The modified "mass-radius"method is used to compute fractal dimension of TEM micrograph of silica powders samples. Two samples of silica powders were analyzed: sample A, with BET surface area $S=400m^2/g$ and sample B with BET surface area $S=53m^2/g$. Both samples have higher fractal dimensions meaning that strong aggregation occurs. The sample A has a higher fractal dimension than sample B, according to their BET surface. Also, for sample B, at shorter scale range of 2nm-20nm, one can compute a fractal dimension of 2.73 ± 0.01 with correlation coefficient = 0.999. Taking into account the lower values of scaling ranges we assign this fractal dimension to correlations between points situated at different depths, and separated in micrograph's plane by lower distances.