Modeling of etching of fractal surfaces at nanoscale

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Etching is one of the fundamental processes for micro and nanopatterning of films in nanoelectronics, Microelectromechanical Systems (MEMS), Bio-MEMS and sensors[1]. It has been shown that this process modifies the nano-roughness of the treated surfaces, which, at nanometer scale, becomes extremely important since it affects the performance of the fabricated device. Thus, last years several works have attempted to understand and control the effects of the etching process on surface roughness by both modeling and experiments [2, 3, 4]. However, the majority of these works was devoted to the study of the roughness formation when the initial surface is flat. The aim of this work is to examine the effects of the etching process on an initially rough surface. The motivation for this study comes from the fact that usually the surfaces to be etched have been previously fabricated by another process (e.g. deposition) inducing initial roughness. Two kinds of etching processes will be examined. The first is wet etching and it will be modeled by the level set method [5]. The second is plasma etching with isotropic flux of neutral etchants and kinetic Monte Carlo method will be used for its simulation. In both cases, the initial rough surfaces can be either periodic (harmonic or no) or self-affine fractal. The results include the evolution of the roughness parameters (e.g. rms value, fractal dimension, correlation length, periodicity) as etching proceeds and its dependence on the roughness parameters of the initial surface. Both etching processes lead to roughness reduction and our main concern is to understand how fast it occurs and what side effects has on spatial surface morphology. Further, scaling arguments for the spatio-temporal dependence of roughness will be presented and will be compared with traditional scaling theories developed for surface growth processes.

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