

First Observation of Anomalous Scaling in Electrodeposited Films

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The evolution of surface roughness is of considerable importance in most areas of surface physics. Models of growth often predict surfaces that are statistically self-affine over a range of length scales, $l \ll lc$. For such surfaces, the interface width, w , scales as l^H , for small l , where l is the length scale over which roughness is measured. The local surface roughness in the simplest models is found to be independent of the growth time. Many examples of this so-called 'normal' scaling have been reported to date. Some models also predict the possibility of anomalous scaling, in which the local roughness depends not only on l , but also on the growth time. In the case of anomalous scaling, the interface width scales as $l^H t^\beta$, ($l \ll lc$). We report the first electrochemical results consistent with anomalous scaling and investigate the experimental conditions required to produce normal and anomalous scaling surfaces. Galvanostatic electrochemical deposition of copper from additive-free acid sulphate solutions was performed onto gold substrates to produce films of various thicknesses. The interface width, w , was determined, as a function of l , by ex-situ atomic force microscopy. The type of scaling was found to be dependent on the ratio of the deposition current to the diffusion-limited current. At high values of this ratio, anomalous scaling was observed, while normal scaling prevailed at low values. This dependence was found to be independent of the solution concentration and temperature over the ranges measured. These results suggest that bulk diffusion of material to the electrode determines the type of scaling exhibited by the deposited surface.