Scaling analysis of roughness evolution in electrodeposited films

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For any electrodeposited film or coating, the surface roughness is one of its most important properties and considerable effort has been devoted to roughness suppression or control through the use of additives etc. To be useful, descriptions of surface roughness should recognize that for real systems, the magnitude of the roughness depends on the length scale over which it is measured. Experimental (or simulated) data on the root-mean-square deviation of the surface height from its mean value (rms surface roughness) or on the correlation of surface heights measured at different points on the film is therefore particularly valuable when presented as a function of length scale l and deposition time t.

When presented in this form, it has become clear that for many systems where growth commences from a flat surface, the surface roughness shows power law dependences on both l and t. Pure power law relationships are scale-invariant (the power-law exponent is independent of the measurement units used), and the determination of power law exponents from experimental or other data is often referred to as scaling analysis. Scaling analysis has proved valuable in analyzing the roughness of films grown by electrodeposition, electroless deposition as well as a wide range of vapour deposition processes. The hope has been that the measured power-law exponents will provide an insight into the mechanisms of growth. Although this sometimes is the case, in practice the process is fraught with pitfalls because what is observed experimentally may not be the limiting behaviour.

For example, we have shown that for many systems the surface roughness for small l shows a power law dependence not only on l, as assumed in the pioneering work of Family and Vicsek [1], but also on the deposition time. Such anomalous scaling is of real interest because it reflects instabilities in the growth.

We will present data on anomalous scaling in electroless and electrodeposited Cu films, and discuss its occurrence in some other systems. We will also compare the application of scaling analysis to highly polycrystalline films and to textured films grown on Cu(100) substrates.

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[1] F Family and T Vicsek, J Phys A 18, L75 (1985)
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