Abstract *(paper not available)*

Influences of Random Rough Surface Morphology on Secondary Electron Yield of Solid Material

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The secondary electron emission (SEE) of solid material plays on important role in many applications such as scanning electron microscopy, multipactor on microwave device, spacecraft charging-up and so on. As one of the main factors of influencing SEE, surface morphology has received extensive concern in recent years. Vaughan considered the overall influence of surface roughness on the total SE yield (SEY) with a "smoothness factor", indicating that increasing the surface roughness could reduce the SEY. But there is still a lack of reliable analysis for the SEE characteristics of solid material under the condition of random surface, and also lack of understanding of the microscopic mechanism. In order to analyze the influence of surface morphology parameters on the SEE characteristics of metal material, a Monte Carlo numerical simulation model based on the theory of electron scattering in a solid material has been established. A comprehensive consideration of the Mott elastic electron scatting model and the Penn inelastic electron scattering model have been adopted, which can accurately simulate the situation of low primary energy(below 10 keV) and obtain better results. On this basis, by using the surface structure model based on grid file, which constructed a series of random rough surface morphologies, SEE characteristics can be obtain. The conclusion illustrated in this paper is that SEY changing with the random rough surface morphology parameters is obvious. The total SEY not only influenced by the root mean square (RMS) roughness, but also by the surface correlation length Lc. The surface correlation length proposed in the paper is to describe the surface similarity along the horizontal direction. One the whole, it is inversely proportional to RMS, and is proportional to Lc. And the results in this paper also show that the SEY of the random samples is mainly affected by the ration of these two kinds of morphology parameters RMS/Lc. The research work of this paper has theoretical value for using surface morphology to increase or inhibit the SEY in scanning electron microscopy and spacecraft charging fields.

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