Using machine learning method to predict the secondary electron yield and explore its influencing factors

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Abstract

Secondary electron emission (SEE) constitutes an important branch of physical electronics and is extensively employed in the domains of microanalysis and electron multiplication. The secondary electron yield (SEY) serves as the core indicator for characterizing SEE, and the modulation effect of SEY directly determines the performance of SEE-related nanofabrication processes, devices, and systems. Regulating SEY effectively hinges on a profound understanding of its influencing factors, a gap that remains prominent in current research. To address this deficiency, this paper proposes a machine learning (ML)-enabled approach. Specifically, a multilayer perceptron (MLP) model is constructed as a reliable simulation and modeling tool for SEY prediction. Experimental validation demonstrates that the error between the predicted SEY of metals and the experimental values is less than 10%. Furthermore, the SHAP (SHapley Additive exPlanations) value method is employed to quantify the influence weights of key characteristics of metal materials on SEY. This ML-aided interpretability analysis deepens the understanding of the intrinsic mechanisms governing metal SEY, thereby providing valuable guidance for the rational design and effective regulation of SEY in nanofabrication processes, and laying a foundation for advancing AI-driven optimization of nanofabricated devices involving SEE phenomena.

Keyword：Secondary electron emission, Metal, Secondary electron yield, Machine learning, Nanofabrication;