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Expediting the determination of electron beam curing process windows for coatings with monte carlo simulation assistance

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Electron beam radiation is advantageous for coating preparation due to its rapid curing and environmental benefits, but its energy and dosage are crucial for crosslinking. Overdosing can degrade the coating and substrate, while underdosing results in poor crosslinking. Traditional optimization of electron beam parameters is inefficient. This study combines FLUKA simulations with EBlab-200 experiments for superhydrophobic silicone rubber and corrosion-resistant Q235 steel coatings, evaluating crosslinking via adhesion, impact resistance, DSC, TGA, and gel content. Optimal crosslinking requires primary electrons to penetrate the coating and secondary electrons to reach the coating-substrate interface, ensuring effective crosslinking. Adjusting inorganic fillers or solid components in the coating formulation allows quick determination of the energy window through simulation. Monte Carlo simulation streamlines coating process setup, reducing experimental needs. Thus, Monte Carlo simulation is an effective strategy for improving electron beam-cured coating development efficiency.

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