Performance Evaluation of edge-based smoothed finite element method for 4-node tetrahedral meshes on Electrodeposition Simulation.

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Abstract

Some finite element analysis results of electrodeposition (ED) simulation [1,2] using the 4-node tetrahedral edge-based smoothed finite element method (ES-FEM-T4) [3,4] are presented in comparison with those using the standard 4-node tetrahedral element (FEM-T4). ED process [5] is an important process to coat car bodies with thin paint film so as to prevent corrosion. A car body is dipped in the paint pool and a high voltage is applied between the body and electrodes, then the car body is covered with paint film based on the principle of electrophoresis. We adopt ES-FEM-T4 as the formulation of FEM in our ED simulation. ES-FEM-T4 is known as a novel finite element formulation that gives more accurate solutions compared to the standard T4 element with the same T4 mesh. However, there has been no research on the performance evaluation of ES-FEM-T4 on ED simulation. In this study, we examine the effectiveness of ES-FEM-T4 by comparing the ED analyses results of ES-FEM-T4 and FEM-T4. A few examples of analyses verify that ES-FEM-T4 is better than FEM-T4 in terms of calculation cost, prediction accuracy and so on. In conjunction with the film growth model and film resistance model, our ED simulator gives the time-varying distributions of film thickness, current density, surface potential and so on for the practical ED process of automotive manufacturing lines.

Keywords: Smoothed finite element method, Tetrahedral element, Electrodeposition simulation, Film growth model, Film resistance model.

References

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