Microscale electrical contact resistance analysis for resistance spot welding

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ABSTRACT

Electrical contact resistance is an important parameter for resistance spot welding which is used for automotive industry. Greenwood proposed the electrical contact resistance model for microscale contacts with various sizes[1]. Babu et al. proposed the empirical electrical contact resistance model which is based on Greenwood's model and is easy to use for resistance spot welding simulation[2].

In this study, a microscale electrical contact resistance analysis method is discussed corresponding to various grade steel plates and surface roughness, and zinc plated steel plate. Resistance spot welding analysis without measurement of electrical contact resistance can be performed by using the microscale electrical contact resistance analysis.

The microscale electrical contact resistance analysis method is combination of an elasto-plastic large deformation analysis and an electric current analysis. Contact pressure and temperature for macroscale resistance spot welding analysis are used to evaluate asperity deformation and temperature dependence material properties. The electric current analysis is performed for deformed shape of asperity obtained by the elasto-plastic large deformation analysis. Three-dimensional microscale finite element model is constructed based on surface roughness measurement. A statistically similar representative volume element (SS-RVE) size is determined by height distribution of the surface measurement results. Periodic boundary conditions are imposed on the surfaces of the microscale finite element model.

The microscale finite element model was constructed based on the surface measurement results of 440 MPa grade tensile strength steel plate by using laser microscope. The SS-RVE size and element size were discussed based on the surface measurement roughness and the electrical contact resistance analyses. The tendency of the electrical contact resistance on contact pressure and temperature for the electrical contact resistance analyses are agrees well with those for Babu's electrical contact resistance model. The dependence of the electrical contact resistance on contact pressure and temperature were discussed from the view point of those path dependencies. The microscale electrical contact resistance analysis can be used for a multiscale resistance spot welding analysis by combining macroscale resistance spot welding analysis. The resistance spot welding analysis for zinc plated steel plate can be performed by considering zinc plating layer for microscale finite element model.

REFERENCES

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