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Tue-Af-Po2.24-04 [103]: Dynamic analysis of sheet metal forming process by uniform pressure electromagnetic actuator using the finite element method

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Due to its high efficiency and uniform deformation force, the uniform pressure actuator (UPA) is a potential electromagnetic forming (EMF) technology for shaping of mesoscale dimensional metals, such as metal bipolar plates. However, because of its complex structure, the current simplified two-dimensional model or three-dimensional model cannot fully reveal the law and characteristics of UPA, such as the role of conductive outer channel, the impact of contact resistance. In this paper, A three-dimensional (3D) finite element model with the equations of the electrical equivalent circuit, electromagnetic field, and mechanical field has been developed for calculating the discharge currents through the forming coil, the magnetic forces acting on the workpiece, and the plastic deformation of the workpiece by COMSOL software. The coil impedance changes during the forming process are coupled to the circuit equation through the coil voltage. The effect of air deformation caused by workpiece deformation in the structure field is coupled to the electromagnetic field through the Moving Mesh. What's more, the contact resistance between the conductive outer channel and the workpiece in the electrical contact area is also considered. The simulation results are in good agreement with the experimental results of the induced current, magnetic field and forming depth. Finally, the general design criteria of the UPA are given, which provides a basis for the industrial application of the UPA.

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