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Design of Pulsed Magnet for Adjusting the Residual Stress Field in Large-size Aluminum Alloy Rings

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Large-size aluminum alloy rings are widely used as connector, transition ring and reinforcing structure in aerospace and other fields. Their performance determine the service life, assembly accuracy and reliability of the equipment directly. However, the residual stress introduced during the manufacturing process lead to the structural instability and poor mechanical properties of the aluminum alloy rings. In this paper, pulsed electromagnetic force is used to deform the aluminum alloy rings into plastic state and eliminate the residual stress in the workpieces. Compared with common methods of eliminating residual stress such as mechanical methods and aging methods, this method possesses many advantages. The electromagnetic drive force is a kind of body force and can be controlled flexibly, and its distribution is uniform and unlikely cause the stress concentration of the contact surface. Different from thin-walled tubes used in the traditional electromagnetic bulging process, the size of aluminum alloy rings studied in this paper are much larger and require high machining uniformity. Therefore, higher performance requirements of voltage insulation, inner support and outer reinforcement are put forward for pulsed magnets. Firstly, this paper uses the finite element simulation software COMSOL Multiphysics to design the electromagnetic bulging magnet of large-size aluminum alloy rings with an outer diameter of 720mm, a wall thickness of 60mm, and a height of 60mm. The influence of the number of turns and layers, and the size of the coil wire on the deformation of the workpiece and the stress field distribution of the ring was analyzed. Subsequently, by optimizing the position, thickness, shape and other parameters of the internal epoxy skeleton and the steel support ring, it can meet the requirements of magnet strength. Finally, the designed pulsed magnet can achieve the 2% plastic deformation that is required to eliminate the residual stress of the target rings.

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