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Research Progress of Friction Stir Riveting (FSR) Technology for Al-Steel Dissimilar Metals Thin-walled Structure

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Facing the urgent need of high-performance joining of Al-steel dissimilar metals thin-walled structures, the new hybrid joining technology of friction stir riveting (FSR) is creatively proposed to break through the bottleneck of existing spot joining technologies. A metallurgical-mechanical hybrid joint is obtained, with rivet-steel sheet solid-phase joining as the main load-bearing characteristics and rivet-Al alloy sheet mechanical interlocking as the auxiliary bearing characteristics. Under the guidance of “volume redundancy principle”, the scientific design of semi-hollow rivet structure is achieved, and the flawless rivet-steel sheet solid-phase joining is realized. Based on systematically experimental characterization, the mapping control relationship between process parameters, bearing characteristics, microstructure and mechanical performances was explored, and the formation mechanism of micro-defects, inclusion suppression methods and fracture mode transformation mechanism were revealed. Moreover, the synchronous development of high reliability FSR equipment system is completed, the design method of integrated high stiffness structure is proposed, the problem of rivet feeding for small aspect ratio rivet is solved, and the on-line monitoring and evaluation of joint quality is realized. Finally, a new high-reliability FSR hybrid joining process of Al-steel dissimilar metals thin-walled structures is formed, promoting the development of high-quality spot joining technology for dissimilar materials.