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Investigation on cracking characteristics of Al-Si coating on hot stamping boron steel parts based on surface strain analysis

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Abstract The purpose of this study is to investigate the relations between surface strains and cracking characteristics of Al-Si coating on hot stamping parts. A high-temperature laser confocal microscope system was used to dynamically observe coating surface appearance evolution during tensile procedure. The results suggest that the cracking behavior of Al-Si coating after austenization shows a strong sensitivity to tensile deformation. Based on hot tensile tests of coated boron steel on Gleeble 3500, Johnson-Cook constitutive parameters were solved and adopted in forming simulations to calculate surface strain distributions of two U-shape parts with different geometries. Hot stamping experiments of the parts were also conducted for coating detection. Coating cracking characteristics including crack morphology, crack width distribution and crack density were obtained using scanning electron microscope and optical microscope. The results indicate that widened coating macro-cracks are dominant in regions subjected to tensile surface strains. At a tensile surface strain higher than 2%, through-thickness macro-cracks are widely distributed in the coating. Additionally, macro-crack width variation in coating shows a similar trend with surface strain distribution. A higher strain rate could weaken this similarity and result in larger crack density and smaller crack width difference. To sum up, it could be feasible to estimate coating cracking characteristics of hot stamping parts based on surface strain analysis.

Keywords: Al-Si coating; Cracking; Hot stamping; Constitutive relationship; Surface strain analysis.