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Materials characterization expertise helps resolve manufacturing questions

The demand for reduced vehicle weight and improved safety and crashworthiness drives the need to increase the use of ultra high-strength steel in making automobile structural components. The use of hot-stamped steel parts has grown by orders of magnitude over the past two decades, but problems that arise during the manufacturing process are often costly, hard to resolve, and can cause lost production time.

Researchers at ORNL's High Temperature Materials Laboratory (HTML) worked with engineers at Cosma International to determine the microstructure, properties, and state of residual stresses of A-pillar inner post components manufactured in its plant in Clinton, Tennessee. These components are supplied to OEMs for assembly into vehicular structures. The team used x-ray diffraction and tensile testing to characterize the microstructure of the material and its tensile properties, respectively, and a combination of x-ray diffraction and finite-element stress analysis to determine the magnitude of its residual stresses. The results helped pinpoint the mechanisms affecting materials integrity during automotive components assembly at the OEM plant.

Technology Achievements

- Using x-ray diffraction equipment at the HTML, the team verified the martensitic microstructure of the hot-stamped high-strength steel used in the A-pillar inner post components and through tensile testing determined the tensile strength and ductility of the material.
- The surface residual stresses were found to be highly compressive, a finding consistent with the manufacturing process involving quenching from 900°C to room temperature with water-cooled molds.
- Finite-element calculations were used to determine the stresses associated with the brazing process used to join the A-pillar posts to the vehicle body-in-white.

Key Accomplishments

- ORNL assembled a rapid-response team to assist Cosma, a global automotive parts supplier, in solving a problem that had interrupted the production and assembly of automotive components at an automaker's factory.
- The quick response enabled Cosma's 800-employee, 334,000 ft^2 facility to resume production rapidly, saving time, and money.
- The investigation provided insight into the nature and magnitude of stresses experienced by A-pillar inner post components when these are assembled into vehicular structures and strategies for minimizing these stresses.

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