A study of hybrid joining of dissimilar light materials using a combination of adhesive bonding and friction riveting

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Relevant Working Groups: WG5

Objectives / Description / Main outcomes

The STSM study is focused on a hybrid joining using a combination of adhesive bonding and friction riveting of aluminium 2024-T351 rivet to PEI polymer in order to improve joint strength. The parametric study of friction riveting was done with CNC machine in position control to establish the correlation between process parameters, final rivet shape, anchoring depths of rivets and the joint strength.

In parametric analysis a rotation speed, feeding depth and feeding rate changed according to the plan of experiments for the first and the second phase of friction riveting process. During experimental friction riveting the axial force and torque were measured using Kistler piezoelectric dynamometer and charge amplifier, National instruments measuring card NI 9215 and National instruments DAQExpress, where a measuring protocol was prepared. After riveting the samples were subjected to visual examination, X-ray examination, pull-out testing using universal tensile testing machine and macrosections were prepared. From the measured forces and torques the heat input was calculated as a result of mechanical energy. From X-ray images the dimensions of produced rivets were measured and the volumetric ratio (VR) was calculated.

Based on results the correlation between process parameters, final rivet shape, anchoring depths of rivets and the joint strength was established. Processing parameters have the influence on the rivet shape and its depth. In the first phase higher axial forces produces higher torque and consequently higher energy, which heats the rivet and base material and as a result of feeding depth pushes the rivet deep into base material. In the second phase higher penetration depths and lower feeding rates produces rivet with anchoring shape and wider rivet ending. Such rivet shape produces beneficial higher pull-out forces.

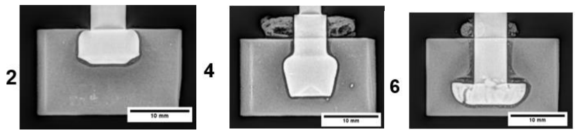

Figure 1: *Typical shapes of the produced rivets a) bell on the surface, b) bell in the middle and c) anchored towards the bottom*

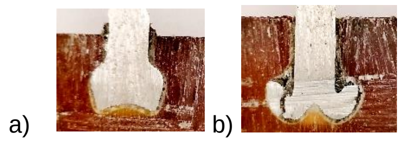

Figure 2: *Macrosection of the rivet a) bell shaped and b) anchored shaped*

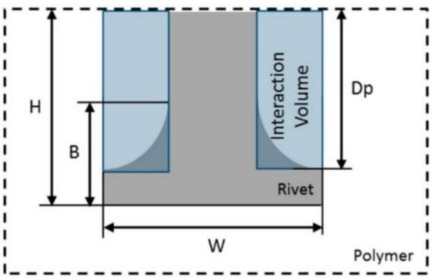

Figure 3: *Definition of volume ratio*

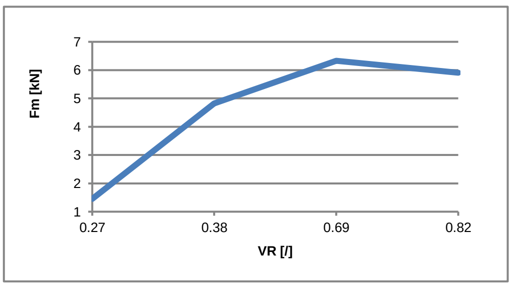

Figure 4: *Pull-out force vs. volume ratio*

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