# Numerical Investigations on the Cold Welding of Aluminum and Steel using Forward Extrusion

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**Abstract.** Industrial demand for light-weight parts has led to the development of hybrid structures where different materials are joint into a single component. Cold extrusion is an efficient process to manufacture such parts with sound joints. Although cold extrusion starts at room temperature, workpiece temperature may reach up to 200ºC during forming. In the current study, temperature effects on the material flow, surface enlargement and contact normal stress on the joint surface during co-extrusion of aluminum and steel materials were investigated using thermo-mechanically coupled finite element (FE) analysis. For this purpose, mechanical properties of EN AW-6082 T6 aluminum and C10 (1.0301) plain carbon steel at work hardened and annealed state were determined experimentally and implemented into the FE model. Investigated workpiece was a round part with an aluminum core and a steel sleeve. Outside diameter of steel sleeve was 15 mm. Diameter of aluminum core was varied between 8.5 mm and 6.5 mm. Rod materials are extruded down to 11.1 mm and 9.6 mm diameters which correspond to plastic strains of 0.6 and 0.9, respectively. Two different die opening angles (2α), 30° and 45°, were used in the extrusion die design. The effects of these changes in material properties, plastic strain and die opening angle on the workpiece temperature, surface enlargement and contact normal stress along the touching surfaces between aluminum and steel samples were investigated using FE simulations and the differences were discussed.