Mechanical Joining Without Auxiliary Element by Cold Formed Pins for Multi-Material-Systems

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Abstract. In order to achieve sustainable and resource-saving products, the use of intelligent lightweight design is a current trend. One approach is the implementation of multi-material systems. However, the joining technology poses a key challenge when combining different materials like continuous fibre-reinforced thermoplastic composites (CFRTP) and metal or joining steel and aluminium. Due to different material properties and partial chemical incompatibilities, established joining techniques without auxiliary element, like welding or clinching, are reaching their limits. Joining dissimilar materials through pin structures has proven as a possible strategy to produce hybrid multi-material systems on a laboratory scale. Nevertheless, this technology is hardly used in mass production due to the complex, uneconomical pin manufacturing process. In this work, cold forming as a promising approach for the production of pins is presented. In a first step, the pins are extruded from a steel sheet (DC04). In a second step, the steel sheets are joined with aluminium (AA6016) or CFRTP by either pressing pins directly into the material or by caulking pins with a pre-punched joining partner. A major advantage of this innovative process is that the product weight is reduced, compared to the application of auxiliary joining elements since the material for the pin is extruded directly from the sheet metal. In addition, the direct press-fit is a suitable method to achieve a tightly sealed joint. Within this work, the extrusion of the pin, as well as the two different joining operations, are investigated showing the fundamental applicability and the potential of the new joining process. The insertion of the pin and the pre-punching are carried out under local heating for the CFRTP. In order to analyze the feasibility of the joining operation shear tensile tests are conducted.