English version below

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Zusammenfassung

With regard to increasing legal regulations, the primary objective of modern lightweight construction strategies is the reduction of operating costs, energy requirements, and environmentally harmful emissions. In particular, in the field of aviation and the automotive industry composite components are therefore increasingly used. The combination of different materials in one component permits the requirement-specific adaptation of local component properties. From the lightweight construction perspective, the use of hybrid components, with constant or even improved mechanical properties, can lead to a reduction in component weight. This is particularly interesting for moving masses since secondary energy-saving potentials can take effect through weight reductions.

Concerning these issues, this thesis investigates the production of composite shafts by means of forward-rod extrusion of hybrid raw parts in conventional cold forging tools. The investigations focus primarily on the material combination of steel-aluminum. The hybrid raw parts consist of a backward-extruded cup with an inserted light metal core. The manufacturability by cold forging results in a very high material efficiency. The simultaneous forming of the two components creates a bond between the outer sleeve and the inner core. The bond properties are analyzed analytically, numerically, and experimentally with regard to form and force fit as well as metallurgical bond. A developed analytical model allows the estimation of the strength of the resulting force fit as a function of the material characteristics as well as the process variables. The developed model could be validated by means of push-out-tests. To achieve a metallurgical bond in composite cold forging, a sufficiently large surface expansion and a high contact pressure between the two components are required during the forming process. Numerical simulations are used to determine the conditions in composite cold forging and the influence of different process parameters. Undercuts at the micro and macro level in composite cold-forged shafts fix the inner core in the outer sleeve by form fit to realize a slip-free transmission of torques. The bond strengths of these bonds are also determined by means of push-out tests. Final investigations show the transferability of the developed technologies to alternative material combinations.

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Composite Cold Forging in Conventional Cold Forging Tools

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Abstract

With regard to increasing legal regulations, the primary objective of modern lightweight construction strategies is the reduction of operating costs, energy requirements, and environmentally harmful emissions. In particular, in the field of aviation and the automotive industry composite components are therefore increasingly used. The combination of different materials in one component permits the requirement-specific adaptation of local component properties. From the lightweight construction perspective, the use of hybrid components, with constant or even improved mechanical properties, can lead to a reduction in component weight. This is particularly interesting for moving masses since secondary energy-saving potentials can take effect through weight reductions.

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