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ABSTRACT

The accumulative roll bonding process allows to produce multilayered composites in which substantially dissimilar metals, both in terms of Young's modulus as well as mechanical strength, can be brought together. For the optimization of such laminated metal composites a fundamental understanding of the microstructural interactions and deformation processes at the internal material interfaces is necessary. The influence of a gradient in hardness and Young's modulus in ultrafine-grained laminated metal composites on the monotonic and cyclic mechanical properties is investigated in this paper. Special attention is put on aluminum/steel composites, as a high gradient in hardness and Young's modulus is present at the layer interfaces. The mechanical properties are determined in monotonic and cyclic three-point bending tests. By scanning electron microscopy, the influence of the meso- and microstructure on the fatigue properties is intensively studied. Furthermore, the internal stresses during elastic straining is calculated using finite element simulations. The results are that for the aluminum/steel composites the monotonic and cyclic properties are drastically increased compared to aluminum mono-material sheets, as well as to composites based on two different aluminum alloys, in which only a gradient in hardness at the material interface exists and the gradient in elastic properties is absent. This is related to a pronounced crack deviation at the material interface as well as to an effective load transfere in the composites.