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MULTISCALE SYNERGETIC MODEL OF THE DIE WEAR IN HOT FORGING PROCESS

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Tool wear in hot forging is responsible for a significant increase of the costs of production and various degradation mechanism are investigated to decrease these costs [1]. A proposition of the multiscale hybrid model of the tool wear in hot forging is described in the paper. The idea of the model was based on distinguishing various mechanisms of the tool wear and evaluation of the mutual influence of these mechanisms. The analysis of factors, cumulative wear of which is mutually dependent, confirmed that all mechanisms influence each other in some way. To cover this, the hybrid die wear model was proposed which includes significance of each mechanism and the mutual relation between them. Additionally, to include change of material parameters, modification of these parameters was account for by a feedback, passing modified die geometry and optionally material parameters into the next iteration of die wear modelling. Developed model consists of the macro scale FE simulations, which supply data regarding local pressure, temperature and length of slip. The following process parameters are supplied in the micro scale: wear mechanisms blocks containing adequate models, significance models and extrapolation routines for results. Three degradation mechanism were considered in the present approach: abrasive wear, plastic deformation and thermomechanical fatigue. As it was shown in [2], material parameters responsible for individual mechanism are changing during forging of many forgings. Therefore, the calculated wear is represented as a die geometry and together with changes of die material properties control the multi-iteration wear prediction. Some mechanisms blocks contain additional components for computing correction of surface parameters altered by thermomechanical fatigue, cracks or increased porosity. Numerical tests of the model were performed for the second operation in the forging of clutch wheel. Weights for mechanisms were calculated for characteristic points of the die. Comparison of predictions and measurements confirmed improvement of the model predictive capability when synergy of the three mechanisms was accounted for.

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