A two-scale simulation framework for Internal Traverse Grinding

We present a hybrid framework aiming at the modelling and simulation of Internal Traverse Grinding of hardened 100Cr6/AISI 52100 using electroplated cBN grinding wheels. We focus on the thermomechanical loading conditions on the workpiece resulting from the interaction of workpiece and tool.

The modelling framework basically consists of three components, namely representative plain strain adaptive finite element simulations on a mesoscale, capturing the proximity of a single cBN grain when cutting through the workpiece bulk. Secondly, we incorporate a geometric-kinematic simulation to gain detailed information on the transient grain-bulk-interaction. With this information at hand, the third component of the framework consists of imposing thermomechanical loading conditions at the macro level based on simulation results which are referred to the meso level.

In the mesoscale simulations, a thermoelastic-viscoplastic constitutive model is implemented to capture the thermomechanical interaction between tool and workpiece. Moreover, an adaptive remeshing scheme is used in this context to overcome mesh dependence and minimise the finite element inherent discretisation error. In this way, the complex chip deformation pattern as well as the thermomechanical state of the resulting bulk surface can be predicted with high accuracy.

The geometric-kinematic simulation uses constructive solid geometry to model the cubo-octahedric cBN grains on the grinding wheel surface in combination with a radial dexel board representing the workpiece surface. This setup enables us to retrieve detailed transient penetration information for a demanded amount of machining time.

Using this framework, we target the prediction of metallurgical effects, such as white layers, on the workpiece on the macro scale in the near future.