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Thermomechanical interaction in the shear cutting affected zone

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Shear cutting is an important process in chipless separation of metallic materials. In terms of quality assessment the formation of the cutting surface is important. Many present investigations deal with the influence of different process parameters, e.g. cutting edge geometry, cutting speed and clearance, on the formation of the cutting surface. Material failure occurs when the shear fracture limit is reached, which depends on the deformation and the stress state. Thereby, material behavior is decisively determined by strain, strain rate and temperature. This variables interact in the shear cutting affected zone during the cutting process. An overall analysis of this complex cause-effect relationships is not possible until now.

Hence, the scope of this research is to develop a measurement setup and evaluation methodology enabling a synchronous analysis of strain, strain rate and temperature in the shear zone. The material behavior is evaluated by measuring the process variables having regard to the three process parameters cutting clearance, cutting edge geometries and cutting speed. For this a shear cutting tool is built up which allows an in-situ high resolution detection of local strains, strain rate and temperature of the material in the cutting affected zone for the first time having regard to the punch speed and the punch penetration. As an example, Figure 1 shows a) the displacement field and b) the derived strain fields during a shear cutting process. The interpretation of the measurement data in combination with an integrated cutting-force-displacement-measurement enables an extended description of the material behavior during shear cutting process until crack initiation. Based on that, specifications on how to acquire a parameter set for shear cutting finite element analysis is derived. The development and testing of the measurement setup and evaluation methodology is an important milestone and the basis for the development of a meta-model for the prediction of cutting surface formation.

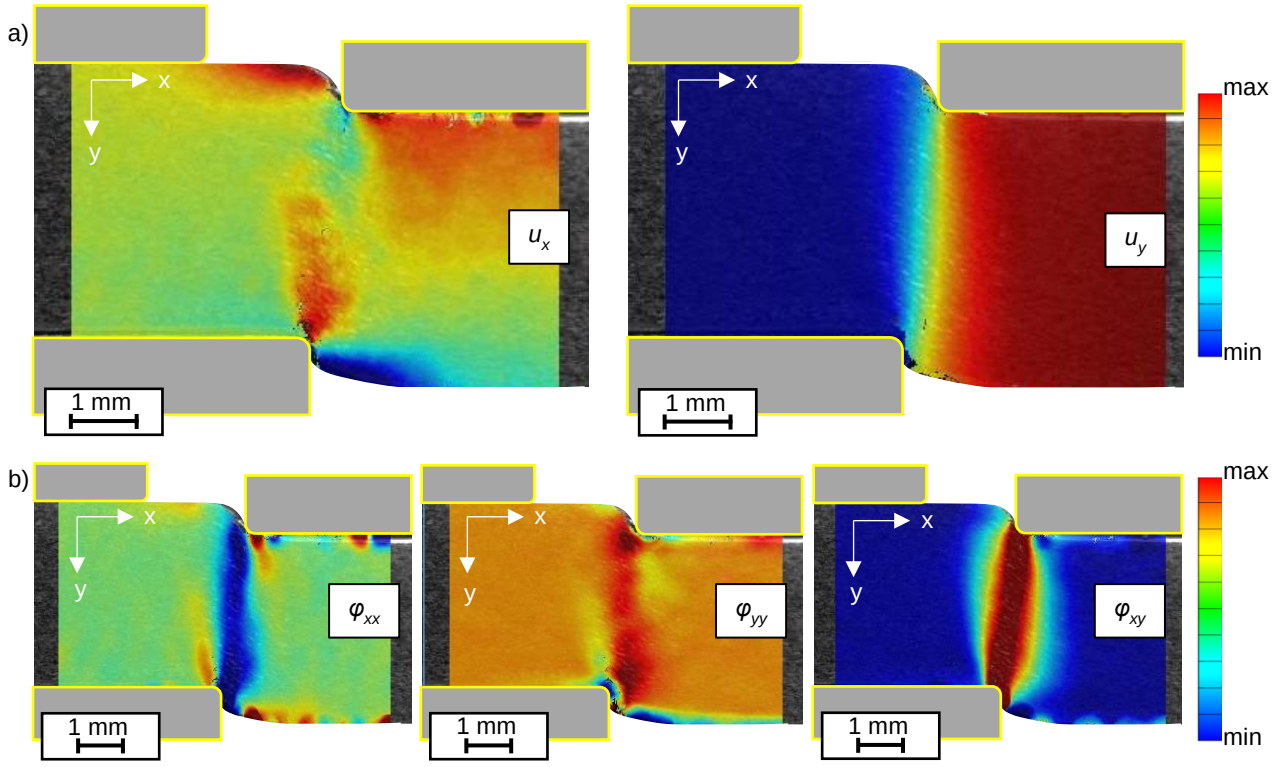

Figure 1: a) Displacement fields u in x-direction and v in y-direction; b) Strain fields φ_{xx}, φ_{yy} and φ_{xy} derived from the displacement fields shown in a)