Numerical Study of Conditions for Subsurface Shear Instability under Contact Interaction

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ABSTRACT

It has been shown in [1] that combination of normal and shear plastic strain induced in sliding provides severe plastic deformation and fast generation of a nanosize subgrain layer in the subsurface of metals in sliding which may lead to shear instability of this layer with respect to shear stress. The origin of such phenomenon is related to changing the deformation mechanism at the real contact areas from shear to grain boundary slipping in nanosize SPD-generated structures. This structurally modified and plasticized material is deformed as a quasi-viscous medium and has very strong adhesion to the counterpart thus causing galling and seizure. It is plain to see that the processed surface's quality may serve as an indicator to notice the shear instability onset which normally has to be avoided when presenting the burnishing process parameters. Another part of the story is that nanosize subgrains generated by sliding in the subsurface provide hardening due to Hall–Petch law and thus may reduce the wear rate of the component processed. So the choice is to generate the optimum thickness nanosize subgrain structure but avoid its instability against shear stress in the subsurface of metals.

The objective of this work is to establish the limiting nanostructuring burnishing process parameters by the criterion of shear instability onset in the subsurface material layer and workpiece-to-tool metal transfer. To achieve this, the numerical modelling of the nanostructuring burnishing process was undertaken. The subsurface structural modification is determined by the power of the friction process, i.e. the energy delivered to the subsurface per time. Numerical modelling was devoted to studying the effect of loading and number of passes on the subsurface structural modification.

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REFERENCES

[1] S.Yu. Tarasov, D.V. Lychagin, A.V. Chumaevski, "Orientation dependence of subsurface deformation in dry sliding wear of Cu single crystals", *Appl. Surf. Sci.*, **274**, 22-26 (2013).