SCRATCH DAMAGE OF ALUMINIUM SURFACES – ASSESSMENT OF DAMAGE MECHANISMS ON DIFFERENT SCALES

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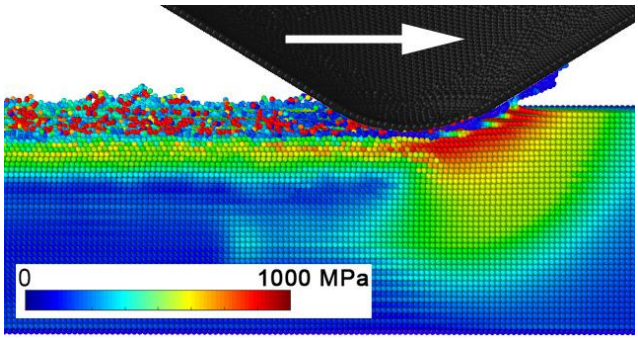
ABSTRACT
Aluminium is an important material for many industrial applications and often used in daily life for decorative reasons. In both cases scratch damage is an unwanted phenomenon reducing the quality of the product. In order to assess the scratch damage induced by a hard indenter, an experimental and numerical approach was chosen in this study. Topographies and microstructural changes resulting from experimental scratches are analyzed in detail, while numerical simulations were used to investigate the stresses within the material leading to these changes.

Scratch experiments were carried out on a conventional aluminium alloy with a diamond indenter of Rockwell C geometry at various loads. Numerical scratch simulations made use of the mesh-free Material Point Method (MPM) implemented in the open-source code LAMMPS, which is well suited for simulating scratch phenomena [1]. We applied a Johnson-Cook visco-plastic material model, parametrized it according to [2], and refined it based on the experimental scratch results.

A strong focus of this paper lies in the analysis of the microstructural changes. For this, cross-sections of the scratches were prepared for nanoindentation and EBSD analysis to investigate the hardening and grain refining behaviour of the aluminium under abrasive load. The results were compared to the stresses calculated with the numerical model.

The numerical results suggest that stresses up to 1,000 MPa occur during scratching. An exemplary stress distribution is shown in Fig. 1. These stresses are believed to lead to the hardening behaviour detected using nanoindentation.

Fig.1 Modelling of stress distribution during scratching



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