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Changing mechanical properties of nanomaterials by surface modification and the impact of capillarity

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Surfaces may influence elastic and plastic properties of nanostructured materials. Nanoporous gold (npg), as one of the most suitable probes for such effects, was mechanically deformed in an electrochemical environment allowing in-situ modification, i.e. electric charging as well as electrosorption of ion species, while the mechanical loading took place. The change in stiffness in the regime of elastic deformation could be well described by the introduction of a surface excess elasticty resulting in total changes of this parameter of 60 N/m for electrosorption and 12 N/m for capacitive charging of the npg surface [1]. Impressingly, these changes are higher than the total value for the excess elastictiy in the range of 8 N/m for uncharged gold surfaces. The surfaces in npg cause considerable capillary forces, in the order of 1 GPa which also influence the plastic deformation behaviour of nanostructured materials. Careful analysis of the observed changes in flow stress in dependence on the applied electric potential allwowed us to differentiate contributions of the surface stress and the surface energy. In contrast to current suggestions relying on atomistic simualtions which favour the surface stress as the relevant capillary parameter, we observe a significant contribution of the surface energy [2].

References

[1] N. Mameka. J. Markmann, H.-J. Jin, J. Weissmüller, Acta Mater. 76 (2014) 272.
[2] N. Mameka. J. Markmann, J. Weissmüller, Nature Commun., in press.

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Primary author: MARKMANN, Jürgen (Helmholtz-Zentrum Geesthacht)

Co-author: Dr MAMEKA, Nadiia (Helmholtz-Zentrum Geesthacht)

Presenter: MARKMANN, Jürgen (Helmholtz-Zentrum Geesthacht)

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