

Supplementary Information: Multiscale
parametrization of a friction model for metal
cutting using contact mechanics, atomistic
simulations, and experiments

Hannes Holey^{1,2*†}, Florian Sauer^{3*†}, Prasanth Babu Ganta¹,
Leonhard Mayrhofer¹, Martin Dienwiebel^{1,4}, Volker Schulze³,
Michael Moseler^{1,2,5*}

¹MicroTribology Center μ TC, Fraunhofer Institute for Mechanics of
Materials IWM, Wöhlerstr. 11, 79108 Freiburg, Germany.

²Freiburg Materials Research Center, University of Freiburg,
Stefan-Meier-Straße 21, 79104 Freiburg, Germany.

³wbk Institute of Production Science, Karlsruhe Institute of Technology
(KIT), Kaiserstr. 12, 76131 Karlsruhe, Germany.

⁴Institute for Applied Materials (IAM-ZM), Karlsruhe Institute of
Technology (KIT), Straße am Forum 7, 76131 Karlsruhe, Germany.

⁵Institute of Physics, University of Freiburg, Hermann-Herder-Straße 3,
79104 Freiburg, Germany.

*Corresponding author(s). E-mail(s): hannes.holey@unimi.it;
florian.sauer@kit.edu; michael.moseler@iwm.fraunhofer.de;

[†]These authors contributed equally to this work.

1 Additional figures

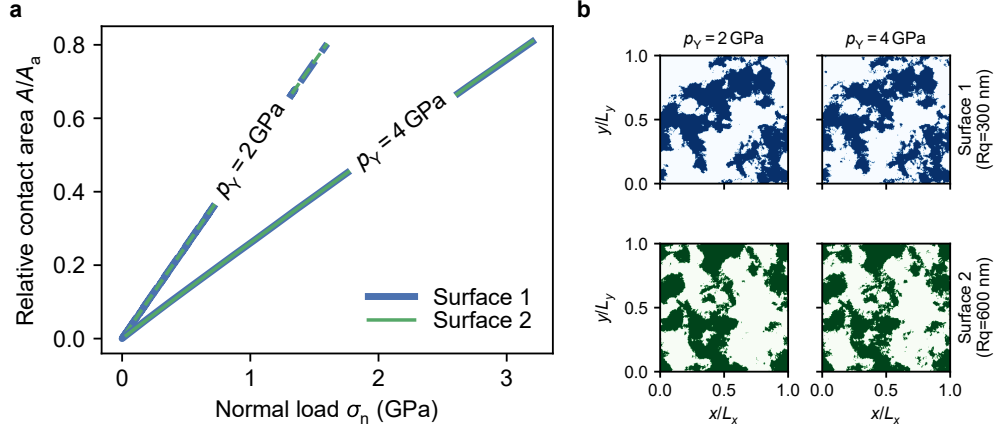


Fig. S1 a Contact area for elastoplastic calculations with the saturation hardness model. The periodic and self-affine surface topographies were synthetically generated with side length $L_x = 333 \mu\text{m}$, Hurst exponent $H = 0.8$, long wavelength cutoff $\lambda_l = L_x/2$, and a resolution of 256×256 . Two different topographies with $R_q = [300, 600]$ nm have been generated and tested for two different hardness values, $p_Y = [2, 4]$ GPa, to show that hardness dominates the contact area. Panel b shows the corresponding contact areas (dark patches) at approximately 42% contact.

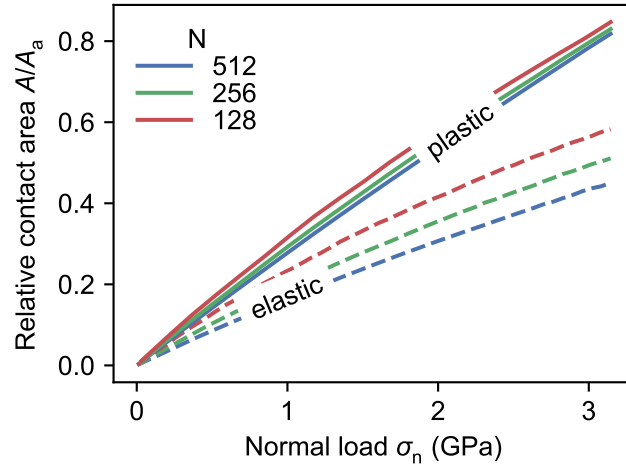


Fig. S2 Contact area sensitivity for different surface roughness resolutions for elastic (dashed lines) and plastic (solid lines) conditions. The calculation is for a synthetically generated, periodic, self-affine rough surface with side length $s_x = 333 \mu\text{m}$, root-mean-square roughness $R_q = 300$ nm, and Hurst exponent $H = 0.8$. The wavelength distribution is cut-off at $\lambda_l = s_x/2$, and N denotes the number of discretization points per dimension.

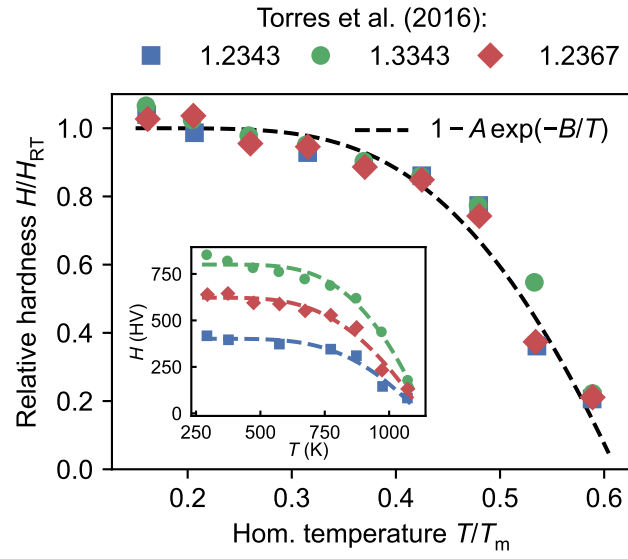


Fig. S3 Temperature dependence of hardness for three martensitic steel grades similar to AISI4140 from Ref. [71]. When normalized by the room temperature hardness, the data collapses onto a single master curve with $A \approx 57$ and $B \approx 4500$ K. The inset shows the individual data and corresponding fits.