

Deformation twins as a probe for tribologically induced stress states

Antje Dollmann^{1,2}, Christian Kübel^{3,4,5}, Vahid Tavakkoli^{3,4,5}, Stefan J. Eder^{6,7}, Michael Feuerbacher⁸, Tim Liening⁸, Alexander Kauffmann¹, Julia Rau^{1,2,9}, Christian Greiner^{1,2,*}

¹ Institute for Applied Materials (IAM), Karlsruhe Institute of Technology (KIT),
Kaiserstraße 12, 76131 Karlsruhe, Germany

² IAM-ZM MicroTribology Center (μ TC), Straße am Forum 5, 76131 Karlsruhe, Germany

³ Institute of Nanotechnology (INT), Karlsruhe Institute of Technology (KIT),
76344 Eggenstein-Leopoldshafen, Germany

⁴ Institute of Materials Science, Technical University Darmstadt (TUD), 64287 Darmstadt, Germany

⁵ Karlsruhe Nano Micro Facility (KNMFi), Karlsruhe Institute of Technology (KIT),
76344 Eggenstein-Leopoldshafen, Germany

⁶ AC2T research GmbH, Viktor-Kaplan-Straße 2/C, 2700, Wiener Neustadt, Austria

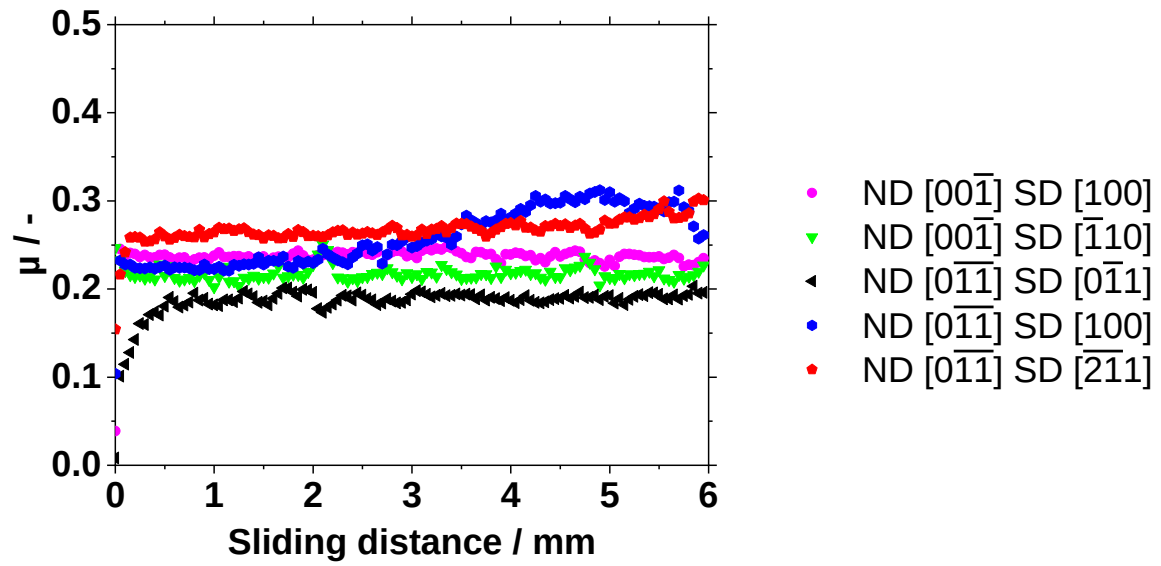
⁷ TU Wien, Institute of Engineering Design and Product Development, Lehnárgasse 6, Objekt 7, 1060,
Vienna, Austria

⁸ Peter Grünberg Institut PGI-5 and ER-C, FZ Jülich GmbH, D-52425, Jülich, Germany

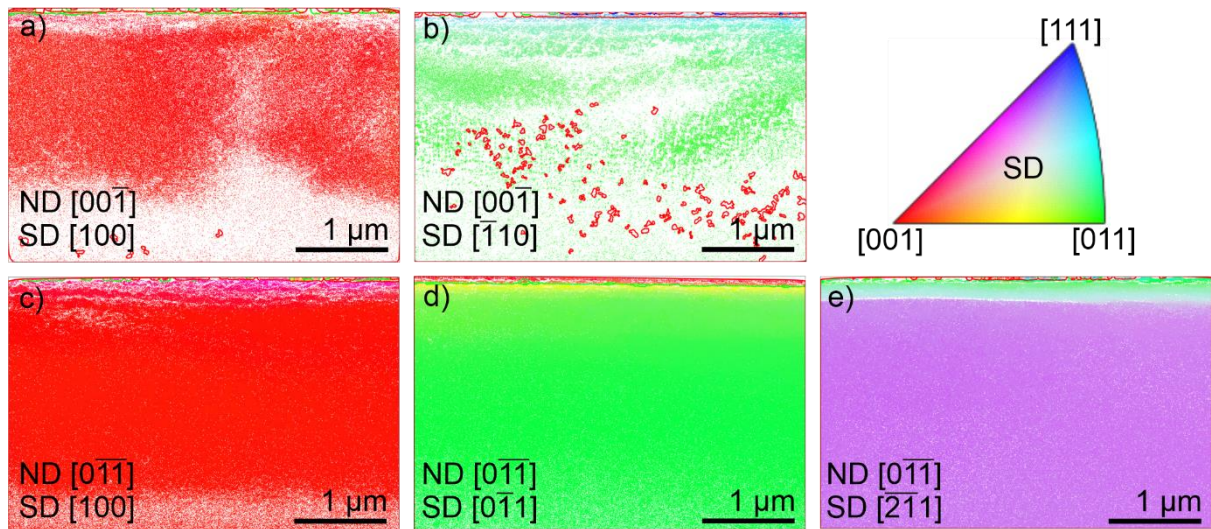
⁹ Department of Physics, Chalmers University of Technology, 412 96 Göteborg, Sweden

*corresponding author: Christian.greiner@kit.edu

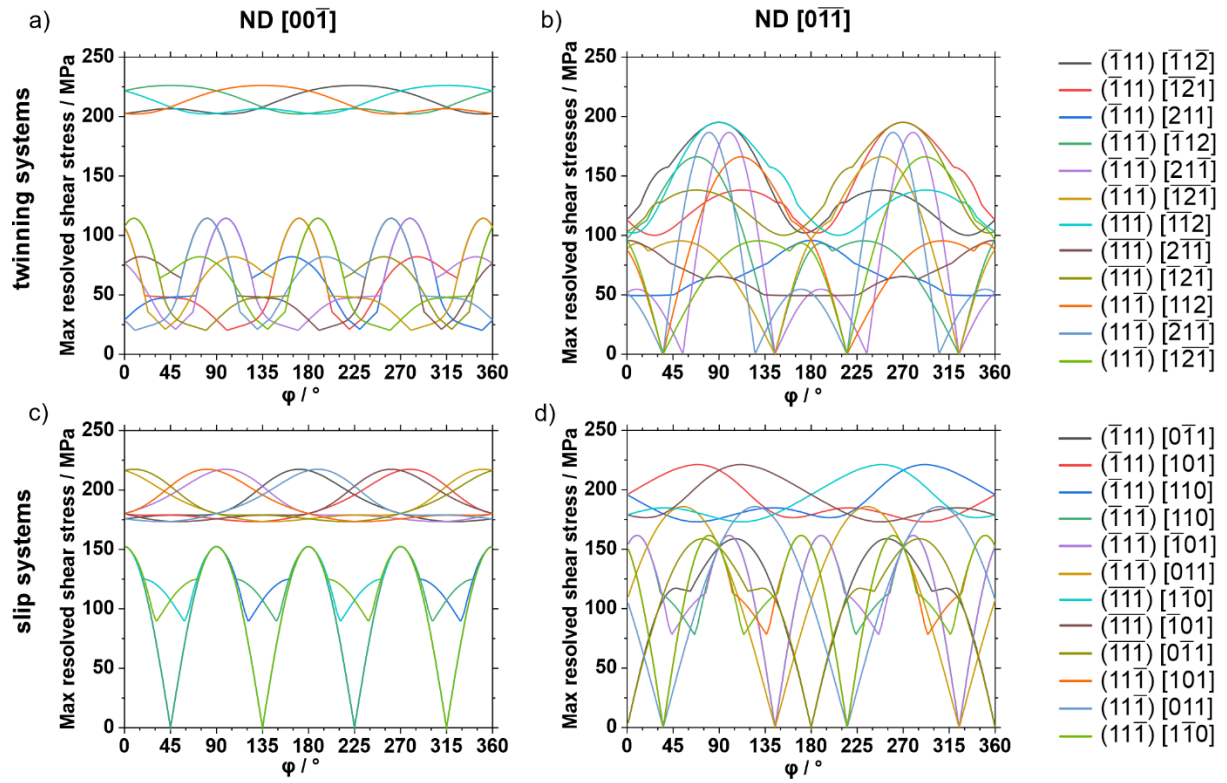
Supplementary Information



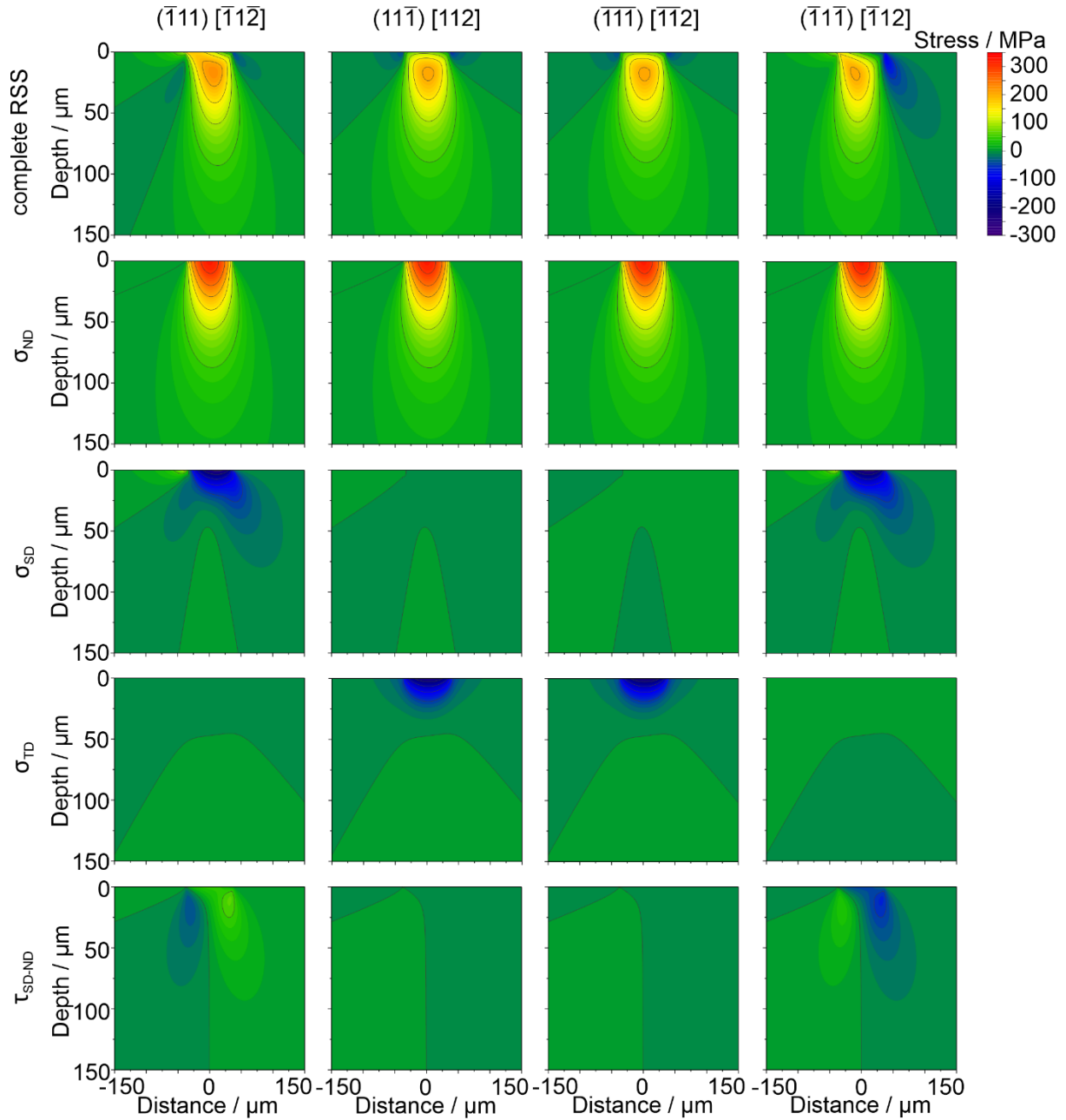
Supplementary Figure 1. Friction coefficient μ as a function of the sliding distance for all crystal orientations and sliding directions investigated.



Supplementary Figure 2. Transmission Kikuchi diffraction (TKD) measurements. a) for ND $[00\bar{1}]$ SD $[100]$, b) ND $[00\bar{1}]$ SD $[\bar{1}10]$, c) ND $[0\bar{1}1]$ SD $[100]$, d) ND $[0\bar{1}1]$ SD $[0\bar{1}1]$ and e) ND $[0\bar{1}1]$ SD $[\bar{2}11]$. The color-coding in SD is given in the inverse pole figure. Green lines represent small angle grain boundaries (3-15°), red lines high angle grain boundaries (> 15°) and blue lines twins. The sliding direction is from left to right.



Supplementary Figure 3. Maximum resolved shear stresses as a function of the rotation angle around ND. Maximum RSS on the twin systems with a) ND $[00\bar{1}]$ and b) ND $[0\bar{1}\bar{1}]$. Absolute maximum RSS on the slip systems with c) ND $[00\bar{1}]$ and d) ND $[0\bar{1}\bar{1}]$.



Supplementary Figure 4. Stress distribution maps for the crystal orientation with ND $[00\bar{1}]$ SD $[\bar{1}10]$ for the four twin systems with the highest resolved shear stresses. The first column shows the results for $(\bar{1}11) [\bar{1}1\bar{2}]$, the second for $(11\bar{1}) [112]$, the third for $(\bar{1}\bar{1}\bar{1}) [\bar{1}\bar{1}\bar{2}]$ and the fourth for $(\bar{1}\bar{1}\bar{1}) [\bar{1}1\bar{2}]$. The first row shows the RSS calculated with the entire stress field, the second shows the RSS calculated with σ_{ND} , the third the RSS calculated with σ_{SD} , the fourth shows the RSS calculated with σ_{TD} and the fifth the RSS calculated with τ_{SD-ND} . The contact point between sample and sphere is at a distance of 0 μm . Positions with a positive x-value are in front of the indenter with respect to SD.