**Supplementary material**

**Small-Scale High-Cycle Fatigue Testing by Dynamic Microcantilever Bending**

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**Data correction for the penetration of the indenter**

The penetration of the indenter into the cantilevers has to be considered. Multiple indents were made with a wedge indenter on FIB-milled H-bars of different sizes as shown in FIG S1.

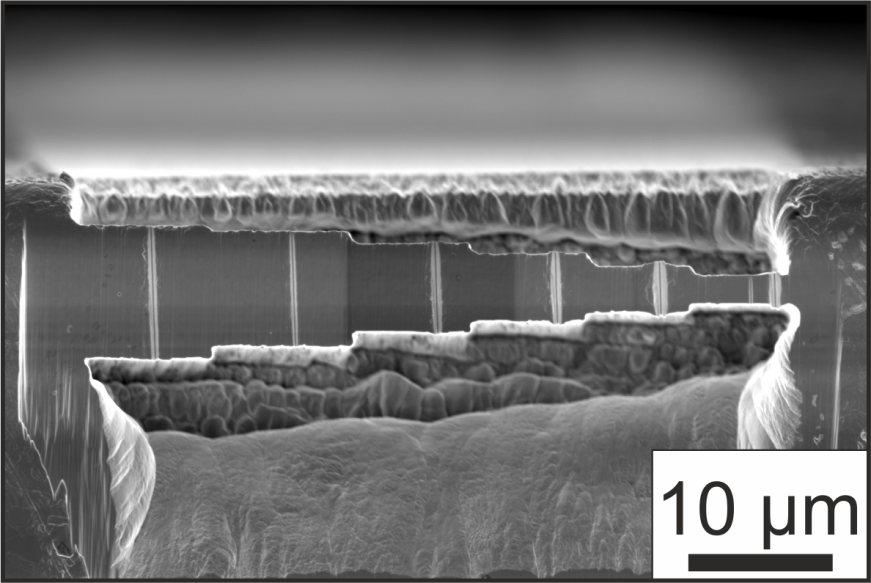


FIG S1: SE-micrograph of an H-Bar with varying width in ufg-Cu after indentation with a wedge indenter.

The resulting contact stiffness-load behavior was normalized by the length of the indent and is shown in FIG S2. The relationship between normalized loading force and stiffness can be described by a polynomial fit. The experimentally measured harmonic stiffness Smeasured is a combination of the imprint contact stiffness Simprint and the stiffness for the bending of the cantilever Scantilever. The correlation of this system is given by the model of two springs connected in series, as described by Kupka and Lilleodden [40]

|  |  |  |
| --- | --- | --- |
|  |  | (S.1) |

As the excitation force remains constant during the experiment, the initial force was used to calculate the imprint stiffness Simprint for the correction of the continuously recorded cantilever stiffness. Due to creep and accumulation of cyclic damage, the indentation depth increases during cyclic testing, which also increases Simprint. As the experiments took place ex-situ, this effect could not be considered in the results. However its influence is rather small, as the initial Simprint in each experiment is at the stage with shallow slope in Fig A2. Therefore an increase of the penetration depth would only lead to a small increase of Simprint. Furthermore Simprint at the start of the experiment exceeded Smeasured and Scantilever by two orders of magnitude. Therefore even an increase from the stiffness Simprint from the beginning of the experiment to the maximal value in Fig A2 by further indentation depth would only lead to a variation of Scantilever by <0.5 %, which is much smaller than the hardening effect and the failure criterion.

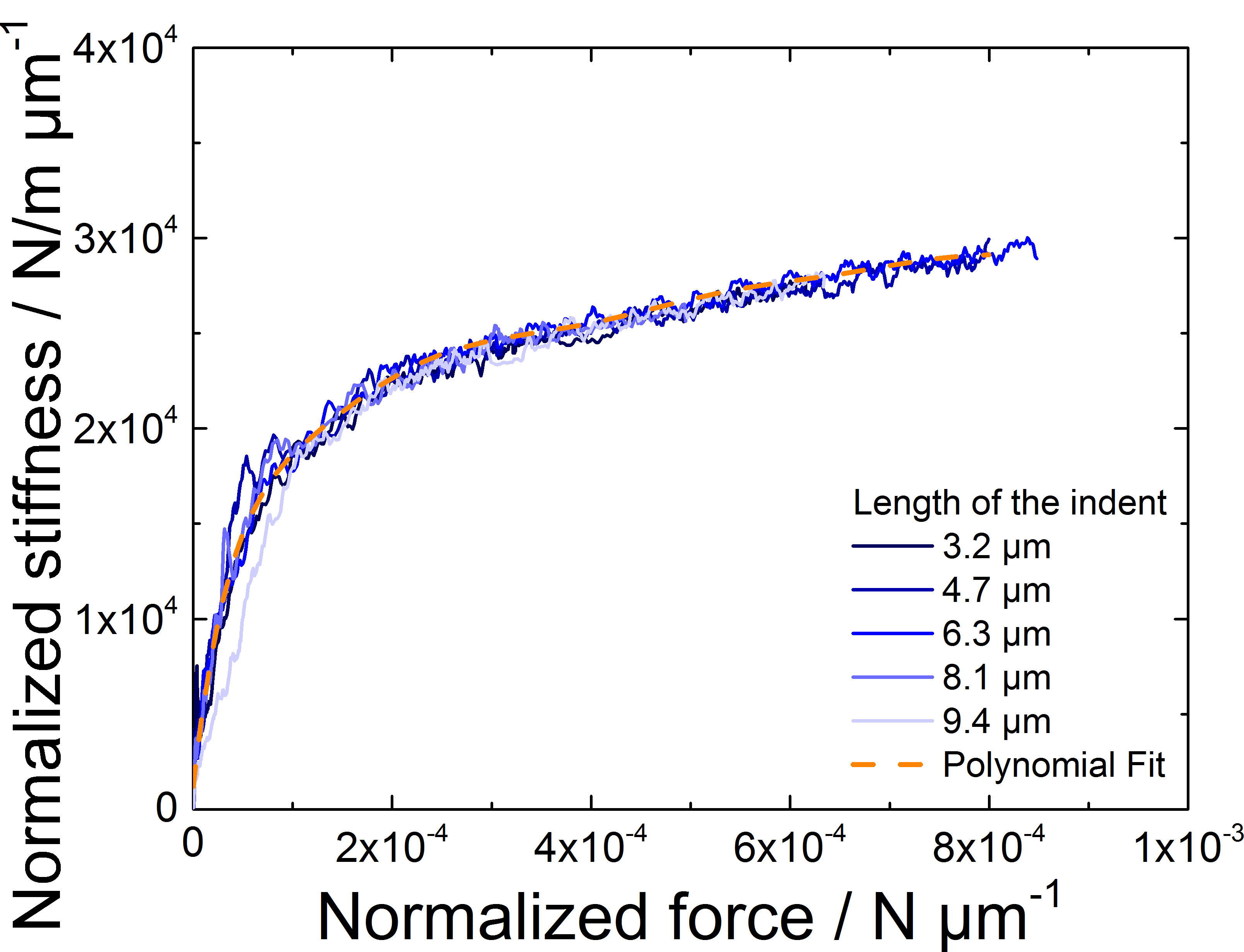


FIG S2: Normalized stiffness-force behavior of the reference indents in the H-Bars.