The Innovation, Volume *2*

Supplemental Information

Unusually thick shear-softening surface of micrometer-size metallic glasses

J. Dong, Y. Huan, B. Huang, J. Yi, Y.H. Liu, B.A. Sun, W.H. Wang, and H.Y. Bai

Supplementary Information for

Unusually Thick Shear-softening Surface of Micrometer-size Metallic Glasses

Jie Dong[1,5#], Yong Huan[3#], Bo Huang[4], Jun Yi[4], Yanhui Liu[1,5], Baoan Sun[1,2,5]*, Weihua Wang[1,2,5],& Haiyang Bai[1,2,5]*

[1]*Institute of Physics, Chinese Academy of Sciences, Beijing 100190, P. R. of China*

[2]*College of Materials Science and Opto-Electronic Technology, University of Chinese Academy of Sciences, Beijing 100049, P. R. of China*

[3]*State Key Laboratory of Nonlinear Mechanics (LNM), Institute of Mechanics, Chinese Academy of Sciences, Beijing 100190, P. R. of China*

[4]*Institute of Materials, School of Materials Science and Engineering, Shanghai University, Shanghai 200444, P. R. of China*

[5]*Songshan Lake Materials Laboratory, Dongguan, Guangdong 523808, P. R. of China*

Supplementary Information including:

Figures S1 to **S9**

Table S1

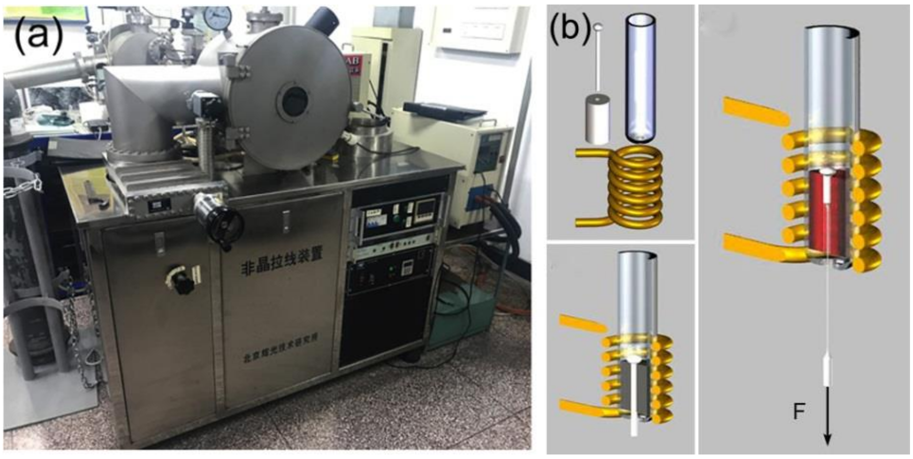

Figure S1 (a) The wire-drawing device. **(b)** The schematic diagram illustrating the wire-drawing process.

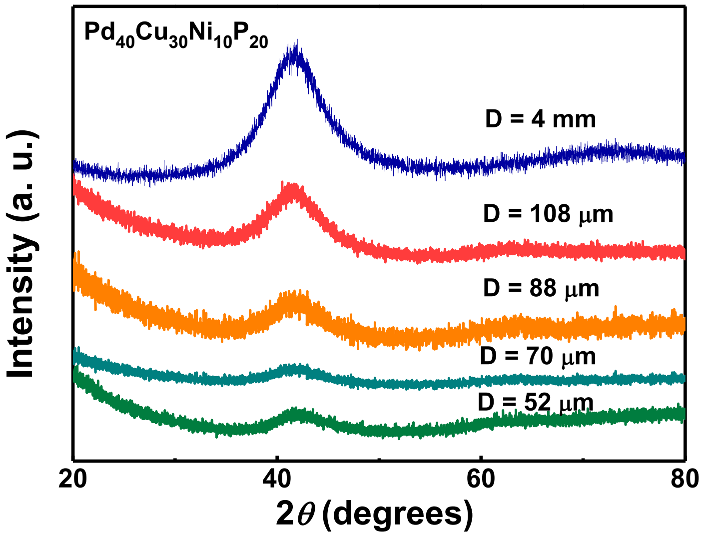

Figure S2 The XRD patterns for the as-cast bulk MG rod with a diameter of 4 mm and the MGWs with diameters from 52 μm to 108 μm. A single broad halo with no sharp Bragg diffraction peaks of crystal phases in each curve confirms the full amorphous structure of the MG sample.

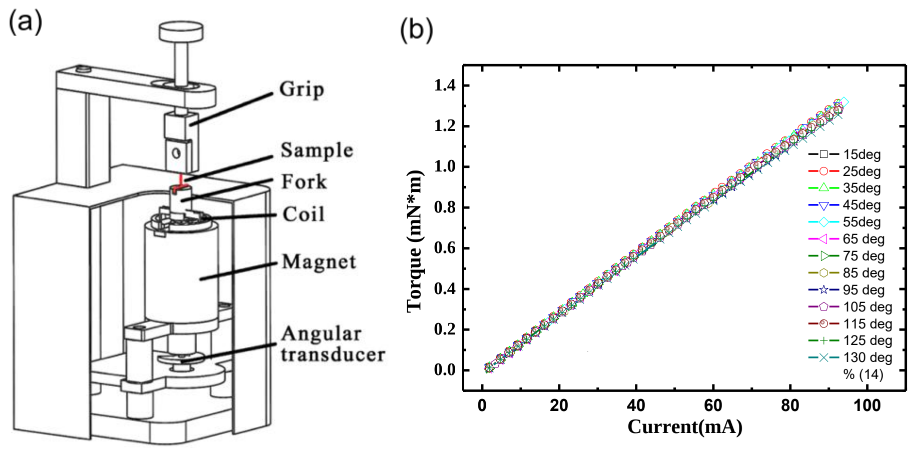

Figure S3 (a) The schematic diagram of the micro-torsion tester. **(b)** The calibrated relationship between current and torque shows a high degree of linearity, confirming the reliability of the torque measurement by the micro-torsion tester.

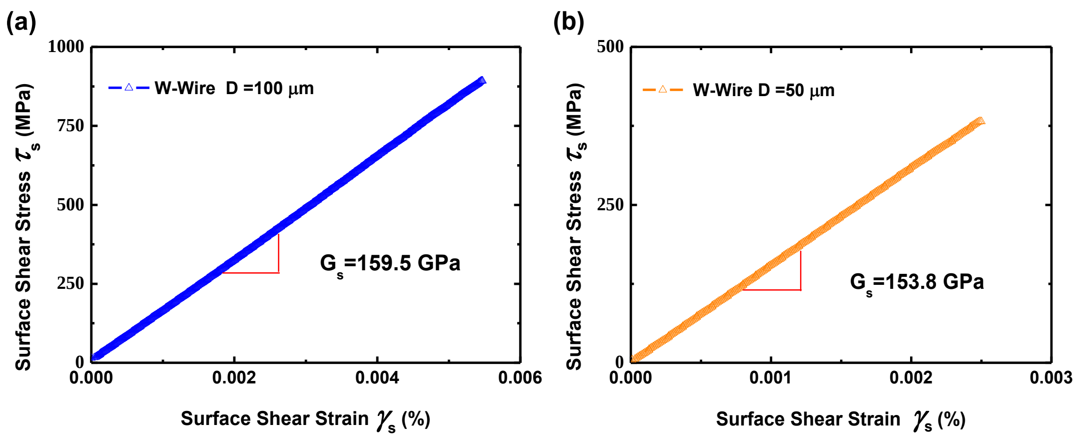

Figure S4 The surface shear stress-shear strain curves for the 100 μm-diameter tungsten wire **(a)** and the 50 μm-diameter diameter tungsten wire **(b)**, respectively. Both of the curves show perfect linearity. The surface shear moduli (G_S) of the tested tungsten wires are calculated by fitting the slope of the linear segment of curves. The measured shear moduli of the tungsten wires are close to the true value of shear moduli of tungsten, confirming the reliability of the micro-torsion tester.

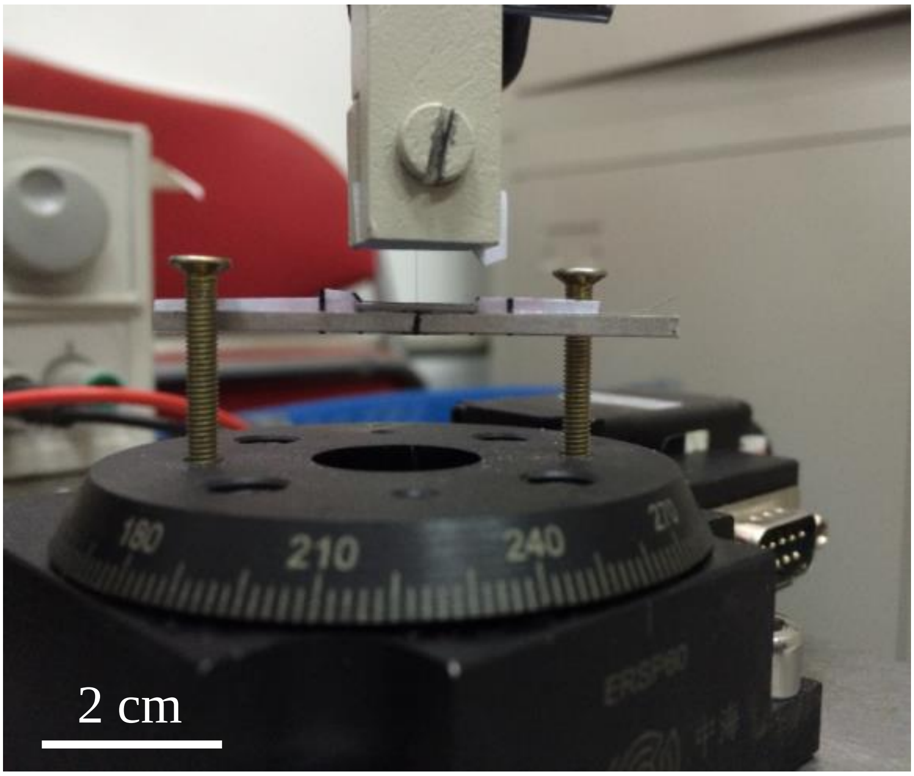

Figure S5 Based on the commercial stepper motor, a torsion device is developed to obtain the rotation angle of the sample. The rotation angle measured is verified by a micro torsion instrument.

Table S1. Sample information and the surface fracture shear strain γ_{sf} of the MGWs measured by the torsion device.

Diameter *D* **(μm)**	**Gauge length** *L* **(mm)**	**Rotation Angle θ (degrees)**	**Fracture surface shear strain** γ_{sf} **(%)**
88	5.5	294	4.1
52	5	419	3.8

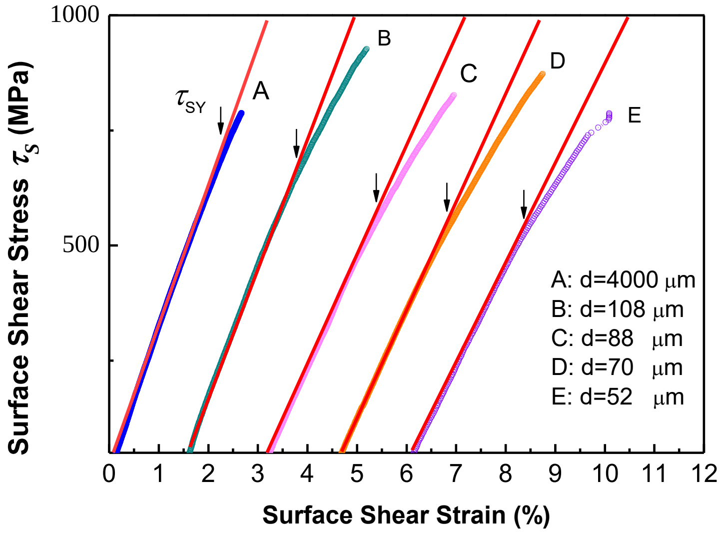

Figure S6 The surface shear stress-strain curves for the MGs samples with different diameters. For each curve, an arrow denotes the stress point where the curve starts to depart from linearity, representing the yield strength (τ_{SY}) of the sample.

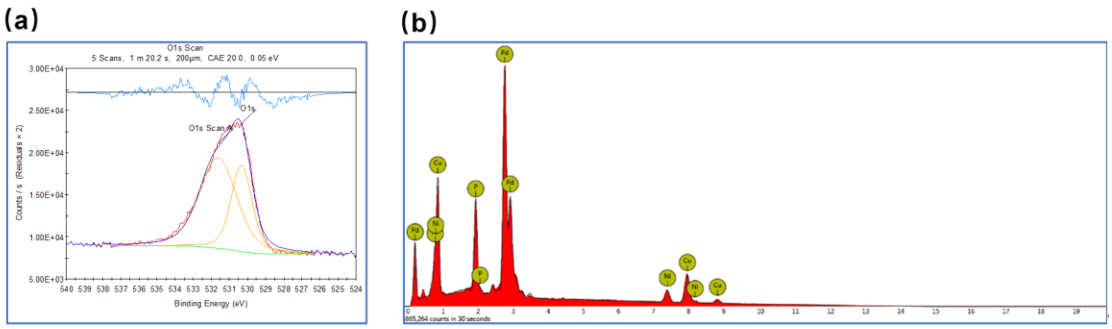

Figure S7 (a) The XPS O1s spectra. (b) The Energy-dispersive X-ray spectrum showing no obvious oxidation on the surface of MG Wires.

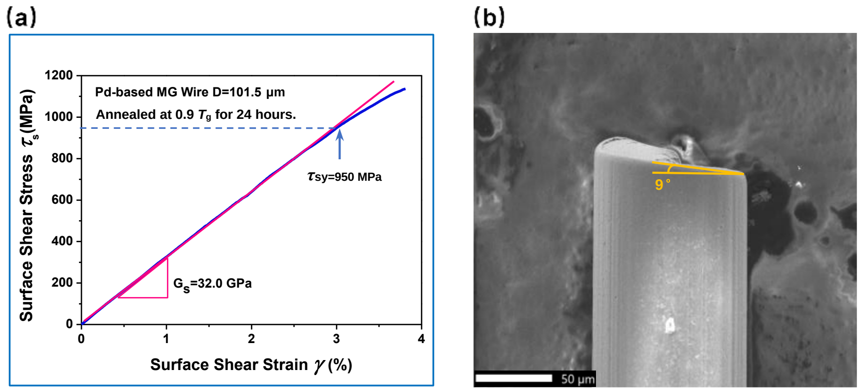

Figure S8 (a) The surface shear stress-shear strain curve and (b) the torsion fracture morphology for the annealed MG Wire after torsion fracture.

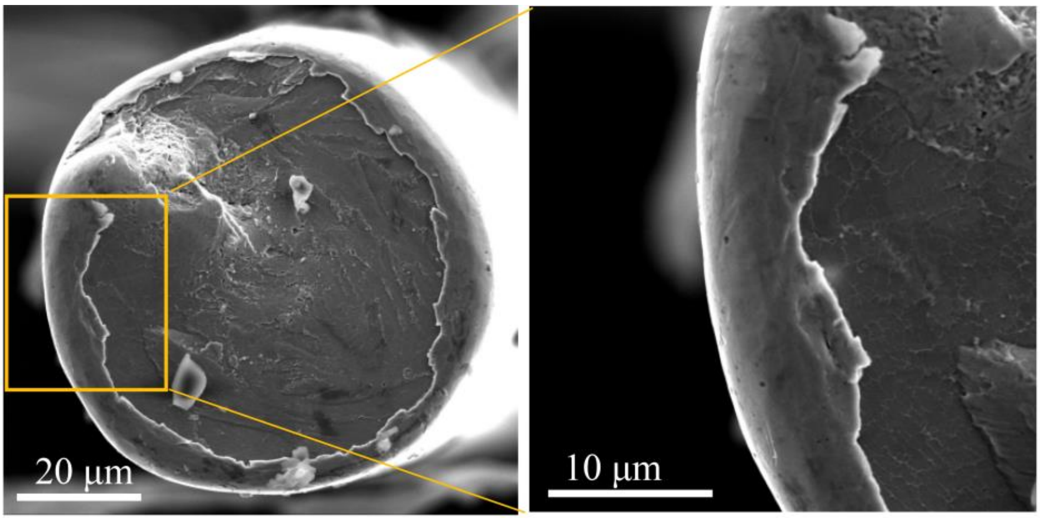

Figure S9 The SEM observation for the fracture morphology of the MGW shows a plastic-flow surface layer with a thickness of ~500 nm after the torsion fracture.