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The Full MoS_2 Monty... Stress!

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Introduction

Everybody knows MoS_2. It is shown throughout the literature that MoS_2 does not follow Amonton's law. The friction behavior is a function of material properties of MoS_2 such the shear strength and contact pressure. At high enough contact pressures, we show that MoS_2 behaves amontonian. We hypothesize that the transition from non-amontonian to amontonian behavior is due to plastic deformation of the substrate.

The man, the myth, the legend...Irwin Singer

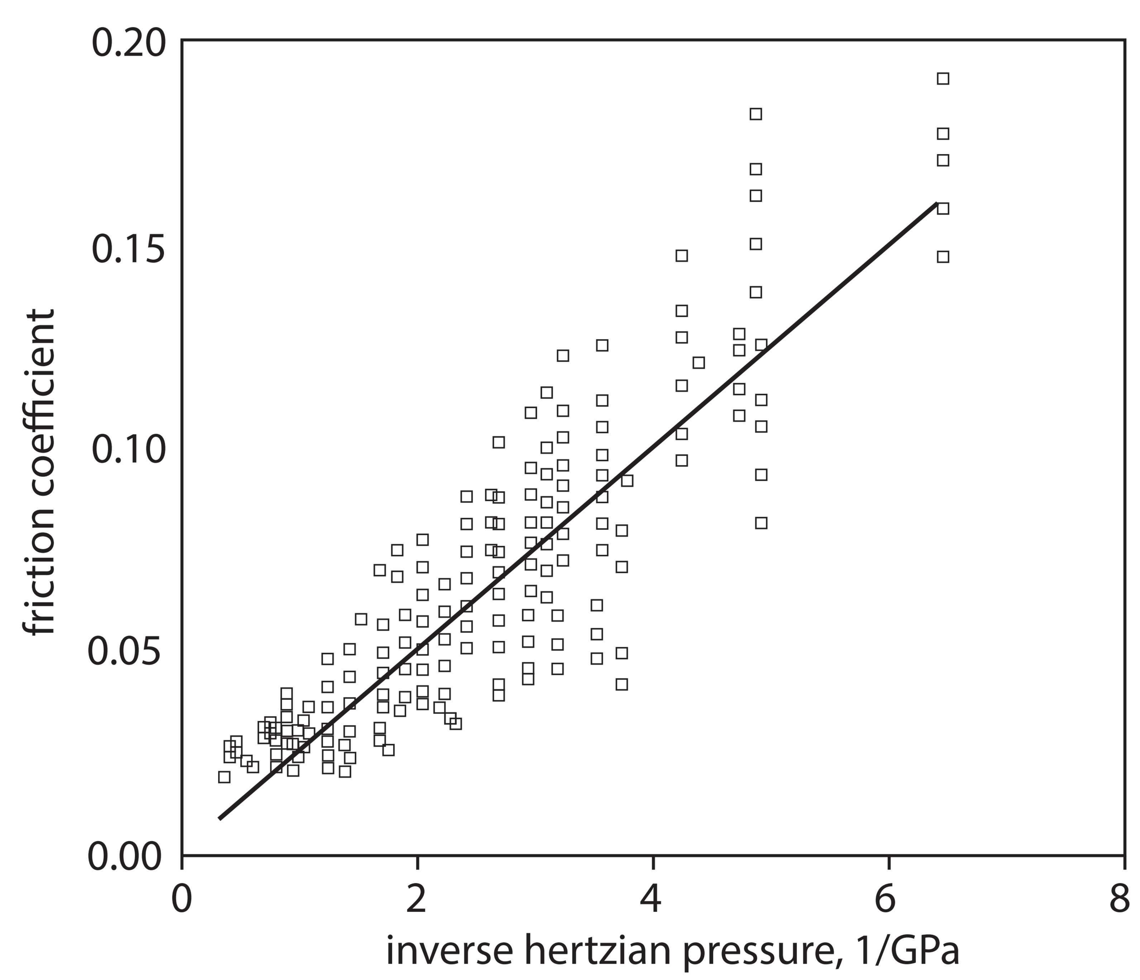

Figure.1: Friction Coefficient vs. Inverse Hertzian Pressure for pure MoS2

The non-amontonian behavior is shown in Fig. 1. The slope shown is the shear strength of MoS_2 and is ~28 MPa. As the inverse hertz pressure gets small (large contact pressure), Singer notes that the friction coefficient starts to plateau. Why is the shear strength constant and why does friction plateau??

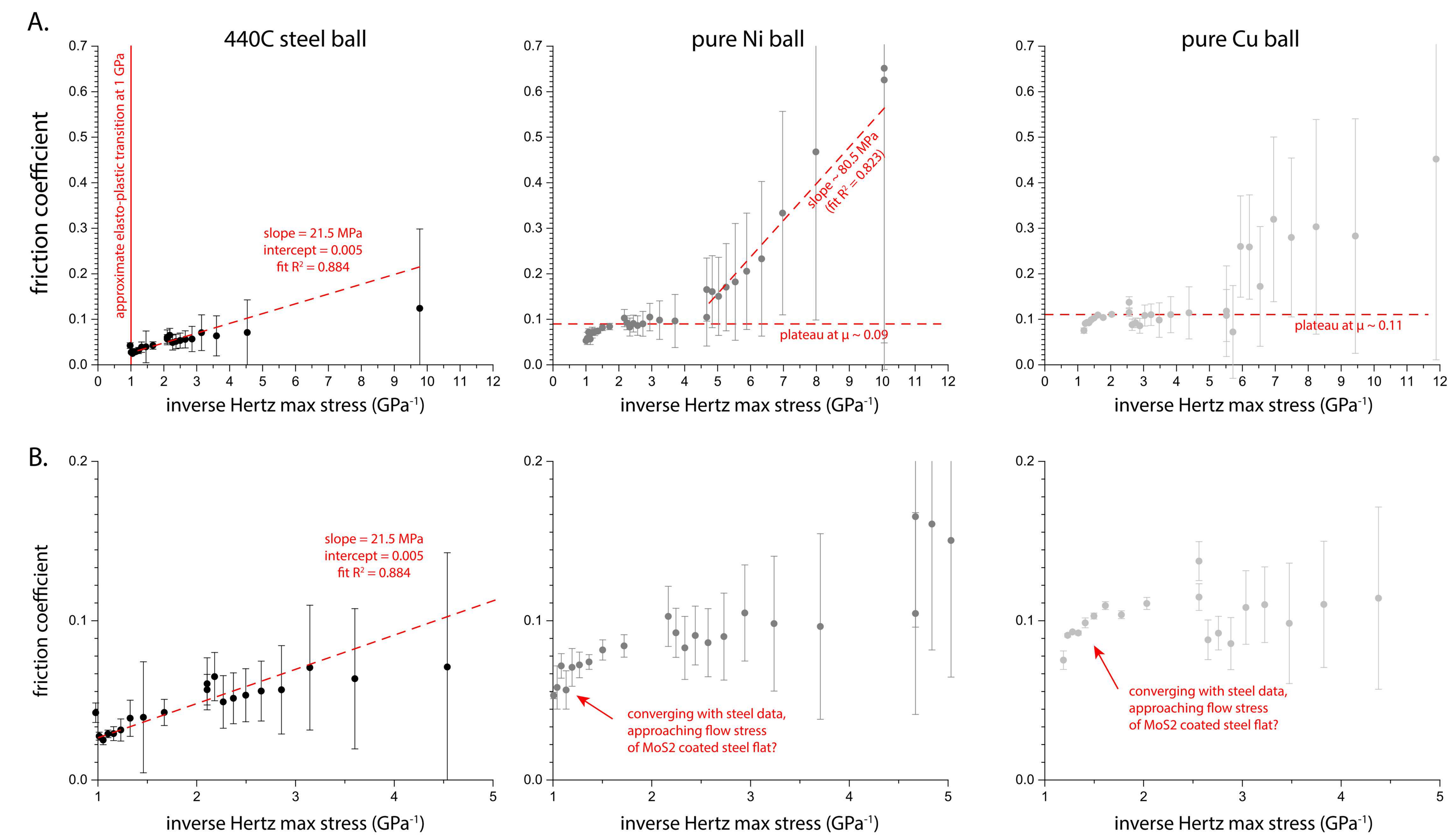

Figure. 2: (A) Plots of friction coefficient vs. inverse Hertz max stress for 440C steel on MoS_2, pure Ni ball on MoS_2 and pure Cu ball on MoS_2 (B) The same plots as in 2A but focused on the high stress regions (<5 GPa^{-1}) and low friction regimes (< 0.2).

Friction coefficients were measured using three different counterfaces on sputtered pure MoS_2 over different contact pressures. For steel on MoS_2, the results mimick that of Singer's, with a shear strength of ~21 MPa. We see the start of the friction plateau at ~1GPa where the elasto-plastic transition for steel lies.

This transition is further pronounced in copper and nickel tests on MoS_2 where significant plateaus in friction coefficient are seen below ~5 GPa^{-1} for copper and below ~6 GPa^{-1} for nickel. Both the nickel and copper tests converge to the elasto-plastic transition for steel around 1 GPa^{-1}, likely due to the steel substrate that the MoS_2 was sputtered on. We also see a slightly larger shear strength for MoS_2 on the copper tests. These plateaus correlate well with the elas-to-plastic transitions for all three materials.

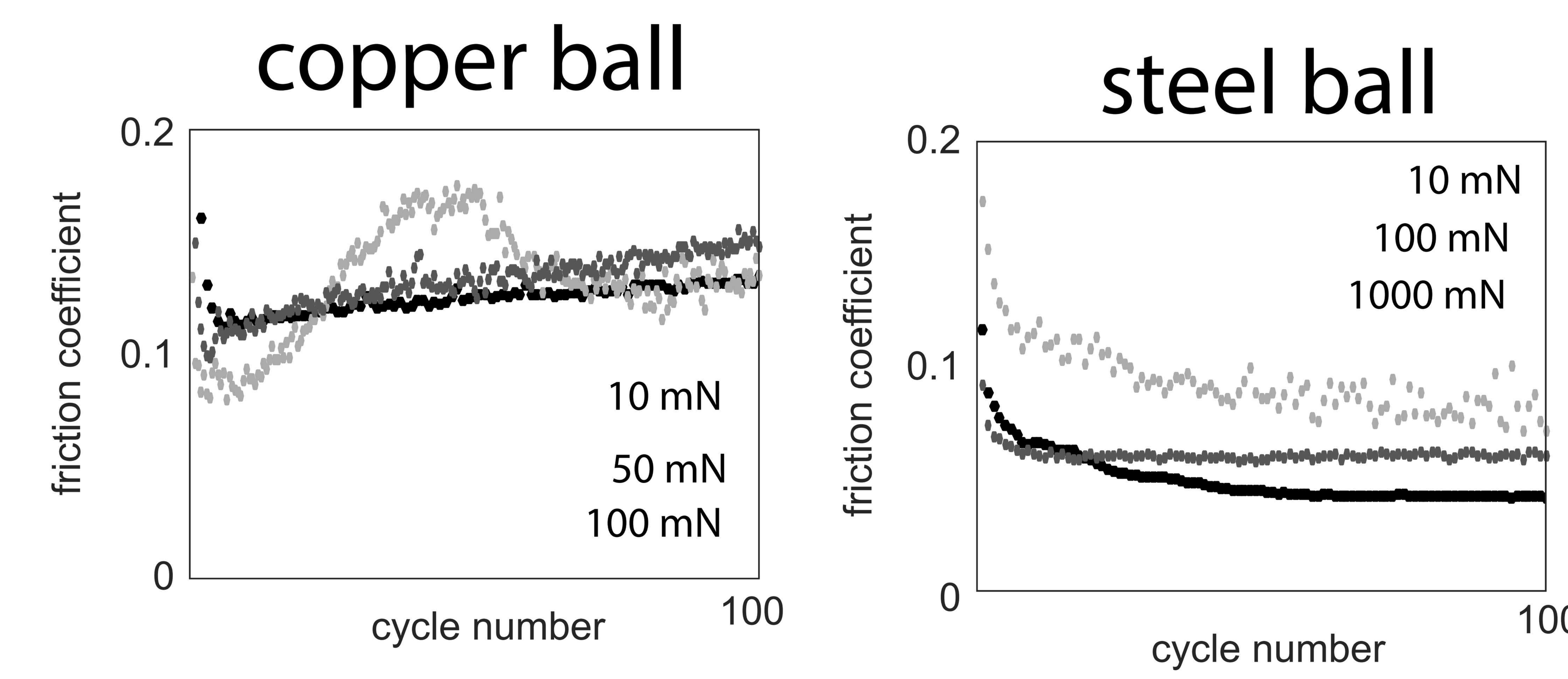

Figure. 3: Evolution of friction coefficient for copper and steel on pure MoS2 at different contact pressures

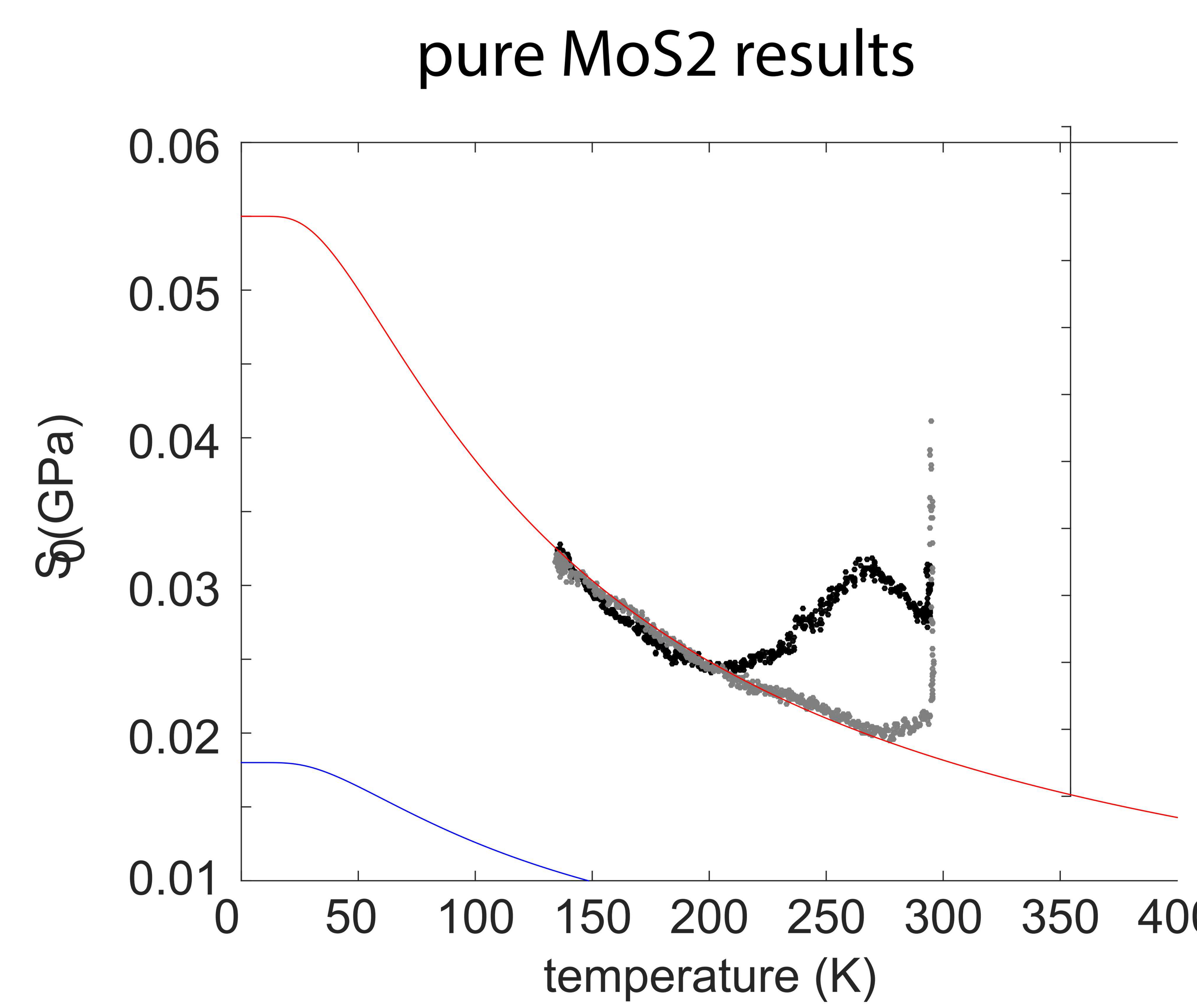

Figure. 4: Ramped temperature friction test ran on MoS2 at 1 GPa contact pressure. Models of shear strength for MoS2 over temperature using nudge-elastic band models match the ex-perimental data well.

Acknowledgments

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