

Table S1. Fitting parameters of the Herschel-Bulkley model of shear stress dependence on strain rate in Figure 5a.

Normal stress (MPa)	Herschel-Bulkley model			
	τ_0	K	n	R2
1.69	0.254	5.97×10^{-6}	0.458	0.9390
5.62	0.278	4.32×10^{-5}	0.413	0.9933
16.85	0.498	1.70×10^{-4}	0.383	0.9837
33.71	0.807	3.63×10^{-3}	0.259	0.9781
56.18	0.944	7.25×10^{-2}	0.142	0.9820

Table S2. Fitting parameters of the exponential model of PaRDF peak dependence on distance, an example at normal stress $P = 5.62 \text{MPa}$ and strain rate $\dot{\gamma} = 6.93 \times 10^8 \text{/s}$ in Figure 7b.

Shear strain	Exponential model		
	A	B	R2
0	7.164	2.493	0.9806
0.5	9.512	1.907	0.9932
1.0	7.809	1.390	0.9988
1.5	11.698	1.001	0.9997
2.0	11.137	0.915	0.9993
4.0	11.724	0.952	0.9993
6.0	14.965	0.876	0.9995
8.0	12.982	1.001	0.9991
10.0	10.903	1.048	0.9996

Table S3. Fitting parameters of the exponential model of stacking size dependence on shear strain at normal stress $P=5.62\text{MPa}$ in Figure 7c.

Strain rate (1/s)	Exponential model			
	<i>C</i>	<i>D</i>	<i>E</i>	R2
6.93×10^8	1.698	0.764	0.924	0.9654
2.77×10^8	1.409	0.636	1.103	0.9864
6.93×10^7	1.257	0.478	1.240	0.9793
2.77×10^7	1.150	0.351	1.347	0.9777

Table S4. Fitting parameters in Equation (7) at normal stress $P = 5.62 \text{ MPa}$ in Figure 8.

Previous strain rate (1/s) (NVT rest)	Logarithmic model		
	<i>a</i>	<i>b</i>	R2
6.93×10^8	0.106	0.079	0.9664
2.77×10^8	0.137	0.044	0.9605
6.93×10^7	0.162	0.025	0.8861
2.77×10^7	0.177	0.182	0.7936
(NPT rest)			
6.93×10^8	0.152	0.013	0.8436
2.77×10^8	0.144	0.010	0.8149
6.93×10^7	0.163	0.011	0.8689
2.77×10^7	0.186	0.008	0.6150