Bruker's Universal Mechanical Tester (UMT) Tribolab

Effect of asperity geometry on abrasive wear modes.

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Working principle and schematic

Bruker's UMT tribolab is a versatile setup which can be adapted for different tribological contact configurations using three stages for motion (see Figure 1). The z-carriage adjusts the specimen's height and applies load on the contact with load range of 2 kN and travel range of 150 mm. The upper specimen is slid to offset along the x-axis using the x-slider with travel range of 120 mm. The upper stages have a speed range of 0.002 to 10 mm/s and travel resolution of 0.5 µm. The lower y-stage slides or rotates the lower specimen, if needed, in an oven for high temperature tests. Load cells measure a range of forces (see table below).

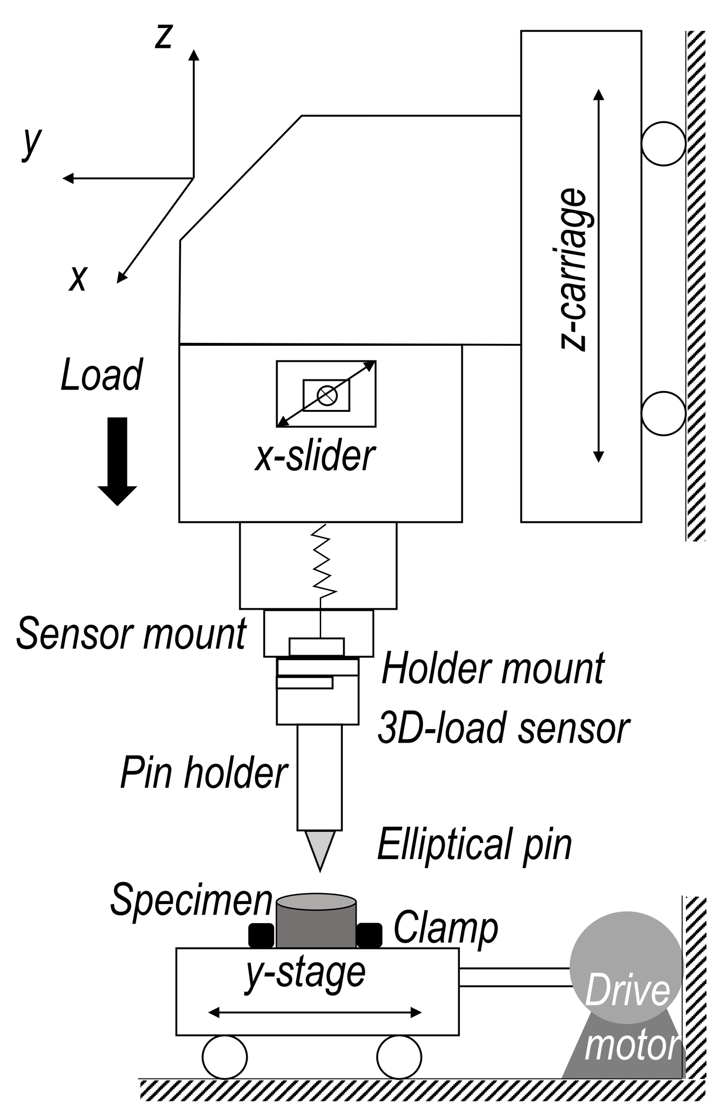

Figure 1. Schematic of Bruker's UMT tribolab for linear sliding (ploughing) experiments.

Component	Types	Specifications	Values
Lower stages	Rotary drive	Speed	0.1 to 5000 rpm
		Max. load	2000 N
		Max. torque	>5 Nm at 100 rpm, 2.5 Nm at 5000 rpm
	Reciprocating drive	Stroke range	0.1 to 25 mm
		Position resolution	1 µm
		Speed	0.1 to 60 Hz
		Max. Load	2000 N
		Stroke vs frequency	60 Hz at 2mm and 20 Hz at 25 mm

Load/ friction cells: 2 axis	DFM-0.5G	Load range	0.05 to 5 N	Resolution	0.25 mN
	DFM-1G		0.1 to 10 N		0.5 mN
	DFM-2G		0.2 to 20 N		1 mN
	DFH-50G		5 to 500 N		25 mN
	DFH-100G		10 to 1000 N		50 mN
Heating ovens	REC-1000 (Reciprocating drive)	Temperature range	Ambient up to 1000 ^{0}C	Resolution	0.1 ^{0}C
	ROT-400 (Rotary drive)		Ambient up to 1000 ^{0}C		0.1 ^{0}C

Results and discussion

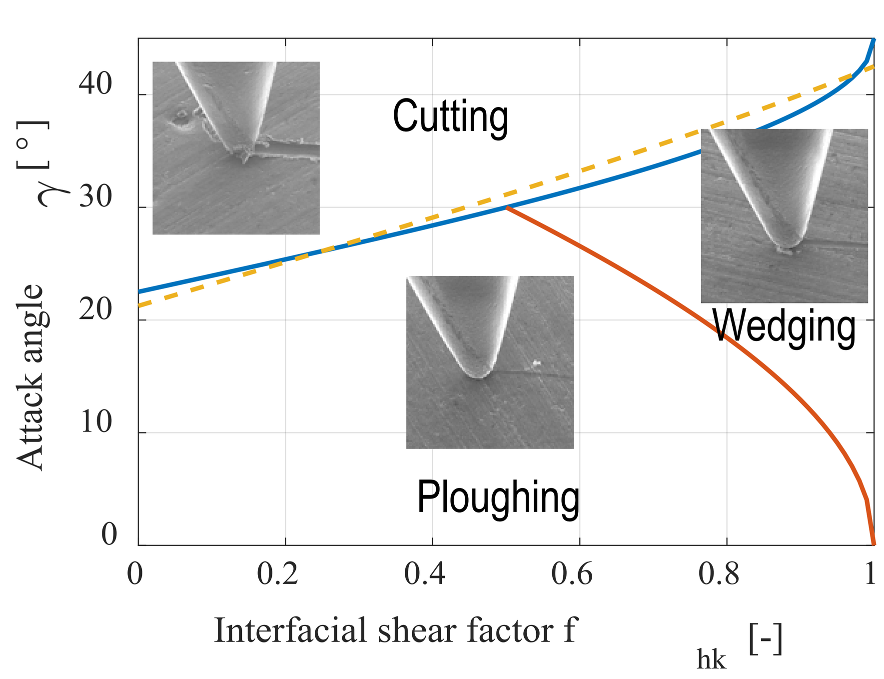

Figure 2. Wear mode diagram, [Hokkirigawa and Kato, 1988] showing ploughing, cutting and wedging wear modes [PhD thesis, Masen, 2004].

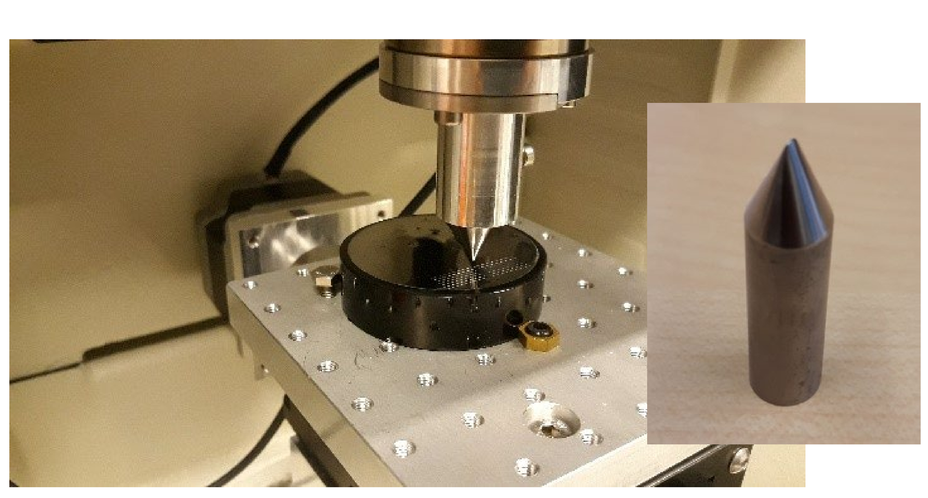

Figure 3. Ellipsoidal tip pins sliding across lubricated steel sheets in UMT2 tribolab with a 3-axes load cell.

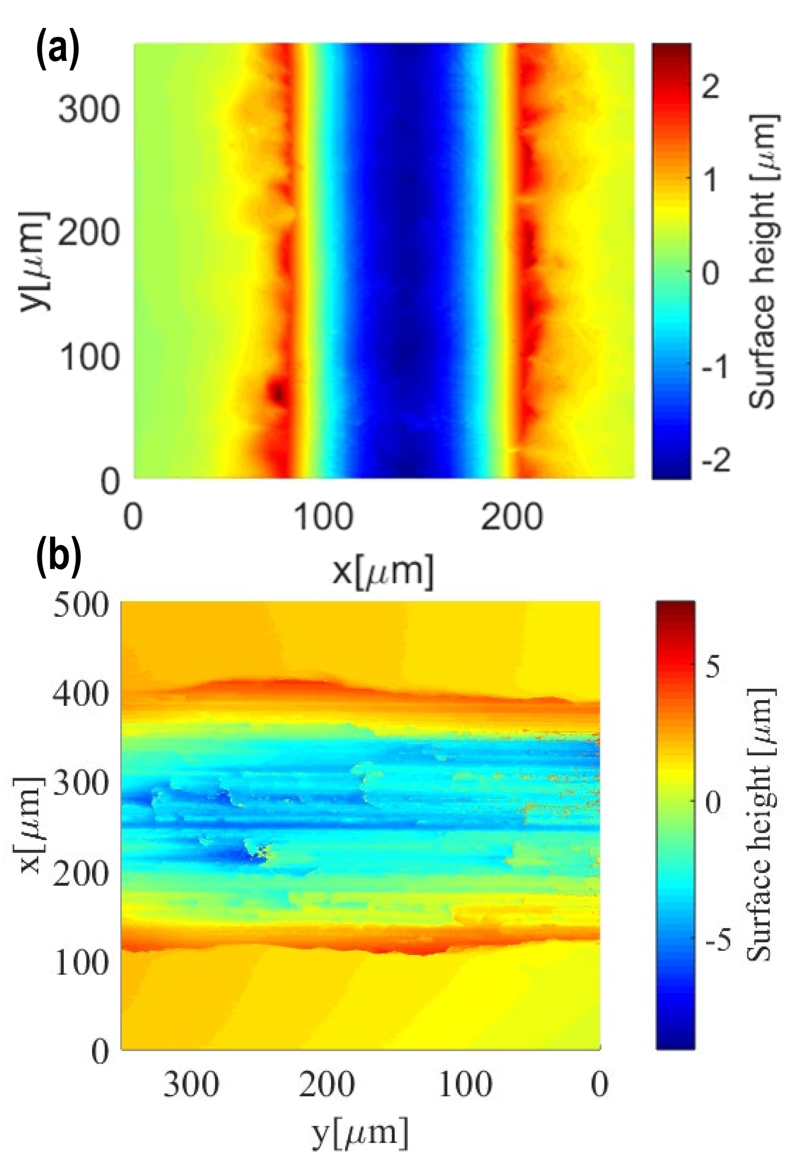

Figure 4. Confocal images of surface heights of wear tracks for a) ploughing and (b) cutting type abrasive wear in single asperity sliding in UMT.

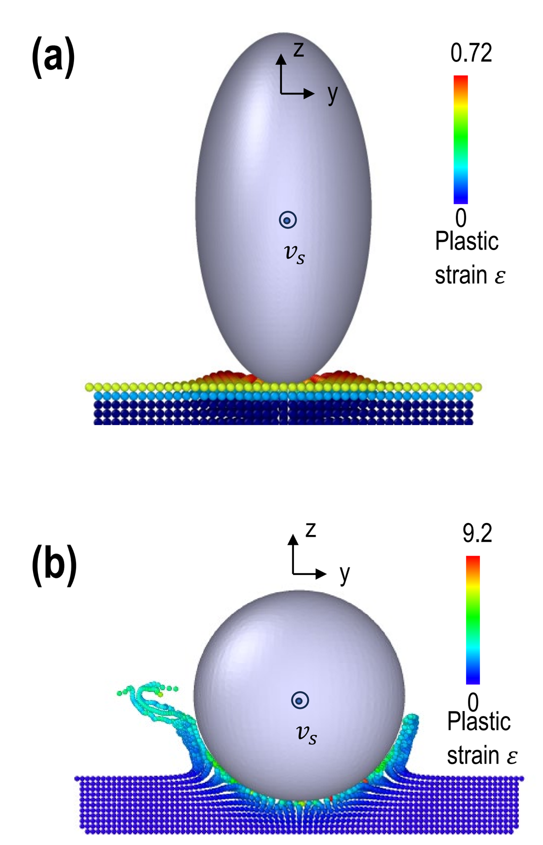

Figure 5. MPM based- single asperity sliding simulations showing a) ploughing and (b) cutting type abrasive wear [1].

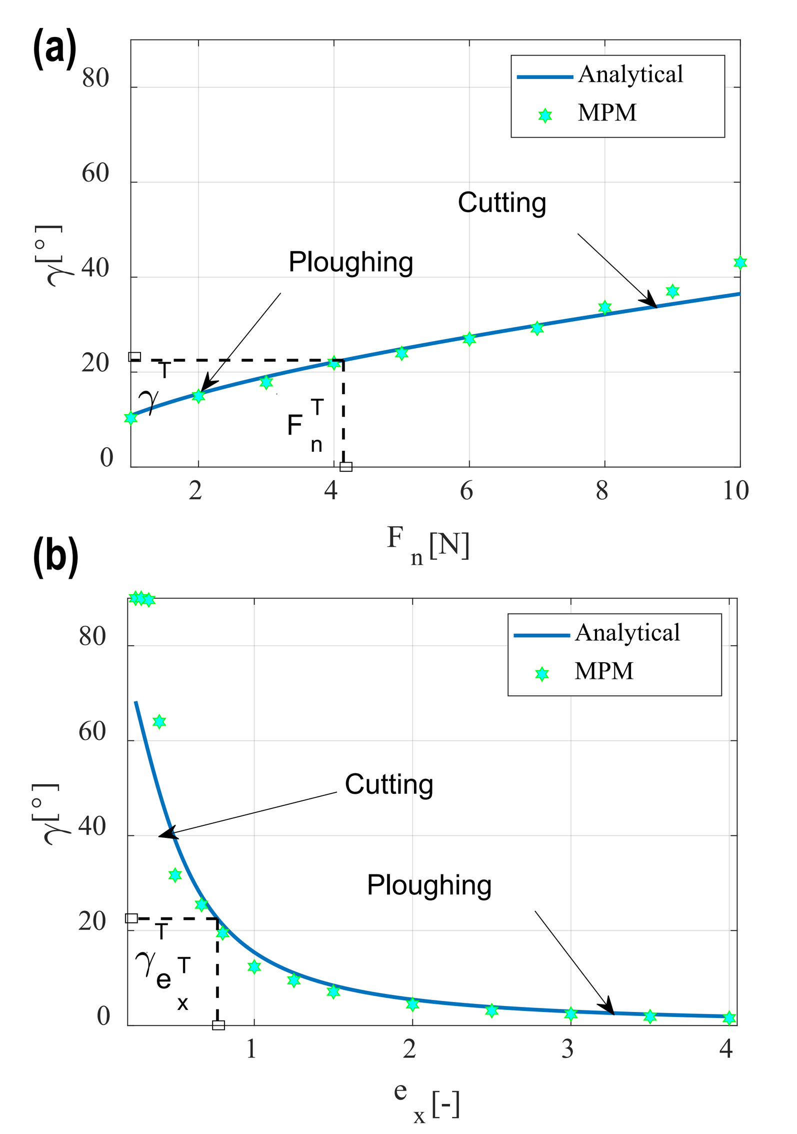

Figure 6. Analytical wear mode diagram showing transition (T) from ploughing to cutting as function of (a) applied load and (b) ellipticity ratio of the pin.

References: [1] *Mishra, T., de Rooij, M., & Schipper, D. J. (2021). The effect of asperity geometry on the wear behaviour in sliding of an elliptical asperity. Wear, 470, 203615.*

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