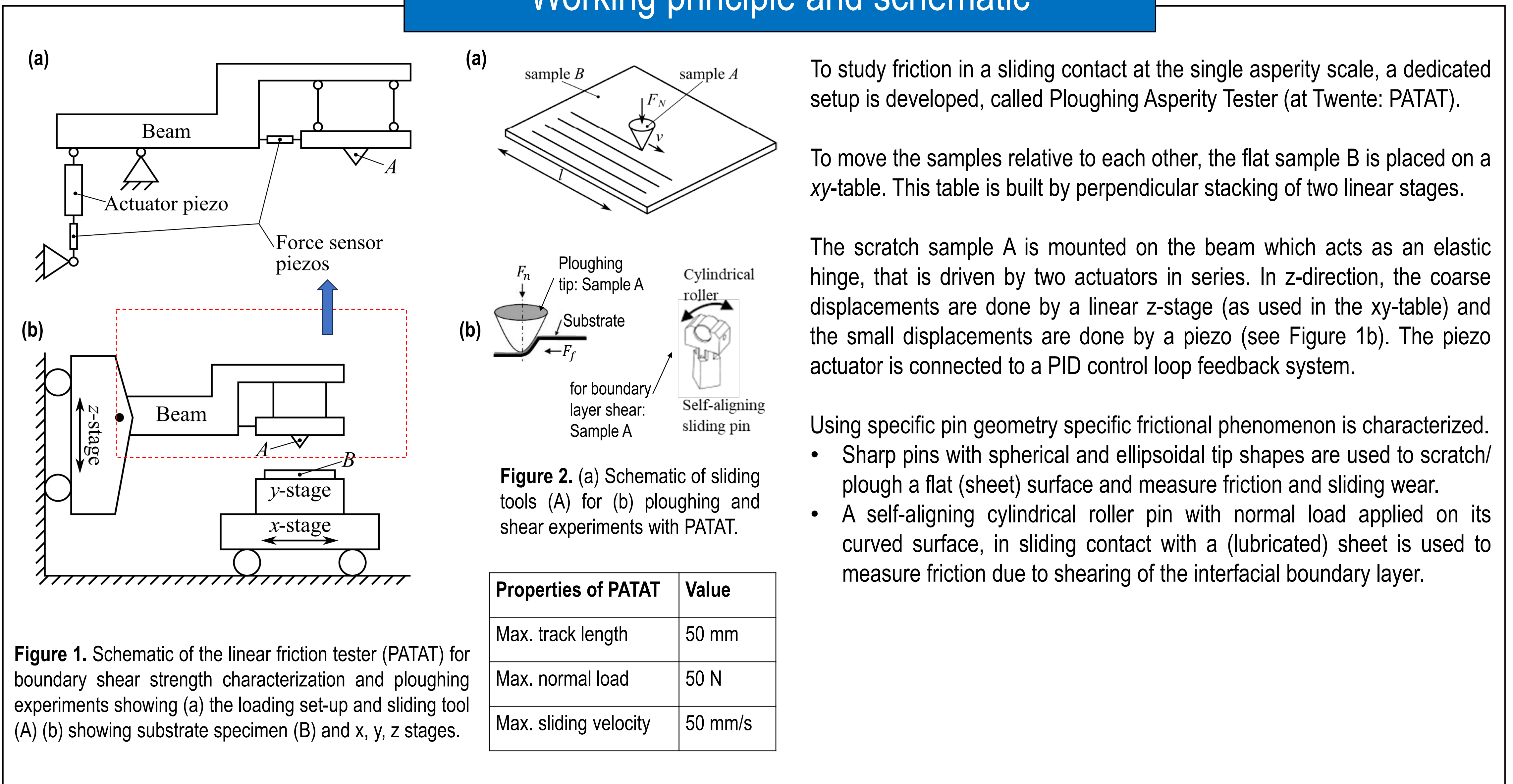


Ploughing Asperity Tester At Twente (PATAT)

Friction in ploughing and shearing of zinc-coated steel sheet.

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Working principle and schematic



To study friction in a sliding contact at the single asperity scale, a dedicated setup is developed, called Ploughing Asperity Tester (at Twente: PATAT).

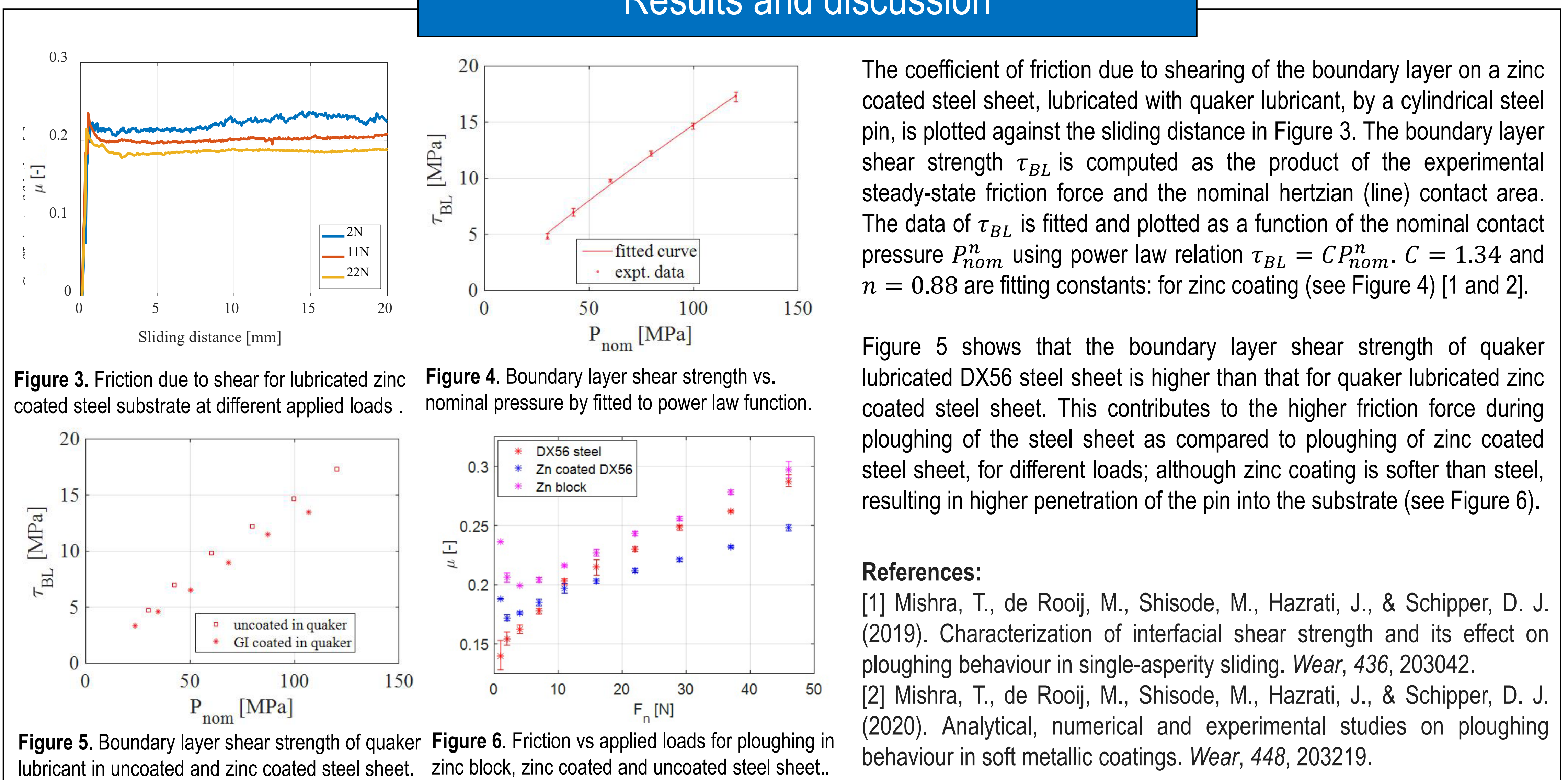
To move the samples relative to each other, the flat sample B is placed on a xy-table. This table is built by perpendicular stacking of two linear stages.

The scratch sample A is mounted on the beam which acts as an elastic hinge, that is driven by two actuators in series. In z-direction, the coarse displacements are done by a linear z-stage (as used in the xy-table) and the small displacements are done by a piezo (see Figure 1b). The piezo actuator is connected to a PID control loop feedback system.

Using specific pin geometry specific frictional phenomenon is characterized.

- Sharp pins with spherical and ellipsoidal tip shapes are used to scratch/plough a flat (sheet) surface and measure friction and sliding wear.
- A self-aligning cylindrical roller pin with normal load applied on its curved surface, in sliding contact with a (lubricated) sheet is used to measure friction due to shearing of the interfacial boundary layer.

Results and discussion



The coefficient of friction due to shearing of the boundary layer on a zinc coated steel sheet, lubricated with quaker lubricant, by a cylindrical steel pin, is plotted against the sliding distance in Figure 3. The boundary layer shear strength τ_{BL} is computed as the product of the experimental steady-state friction force and the nominal hertzian (line) contact area. The data of τ_{BL} is fitted and plotted as a function of the nominal contact pressure P_{nom}^n using power law relation $\tau_{BL} = CP_{nom}^n$. $C = 1.34$ and $n = 0.88$ are fitting constants: for zinc coating (see Figure 4) [1 and 2].

Figure 5 shows that the boundary layer shear strength of quaker lubricated DX56 steel sheet is higher than that for quaker lubricated zinc coated steel sheet. This contributes to the higher friction force during ploughing of the steel sheet as compared to ploughing of zinc coated steel sheet, for different loads; although zinc coating is softer than steel, resulting in higher penetration of the pin into the substrate (see Figure 6).

References:

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- [2] Mishra, T., de Rooij, M., Shisode, M., Hazrati, J., & Schipper, D. J. (2020). Analytical, numerical and experimental studies on ploughing behaviour in soft metallic coatings. *Wear*, 448, 203219.

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