

Mini Traction Machine (MTM)

Measuring the friction coefficient in sliding and rolling contacts

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Working principle and schematic

The MTM is a ball-on-disc instrument for measuring the frictional properties of lubricated and unlubricated contacts under a wide range of rolling and sliding conditions.

Features:

- Traction mapping
- Wear measurement
- Stribeck measurement
- Soft contact tribometry

Applications:

- Formulating greases and other lubricants
- Studying wear of artificial joints
- Tactile perception studies

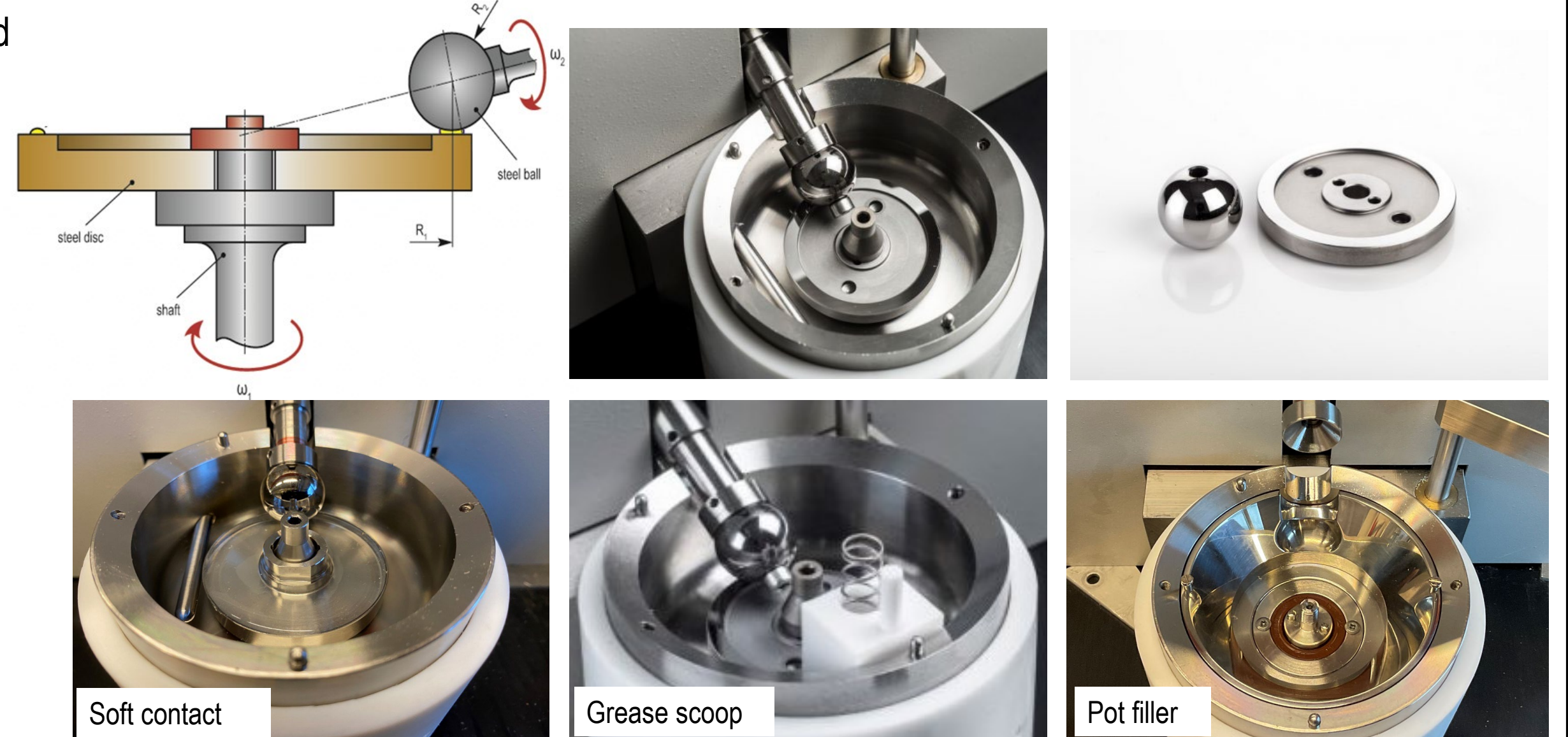


Figure 2: MTM standard configuration, soft contact modifications, grease scoop and pot filler accessories.

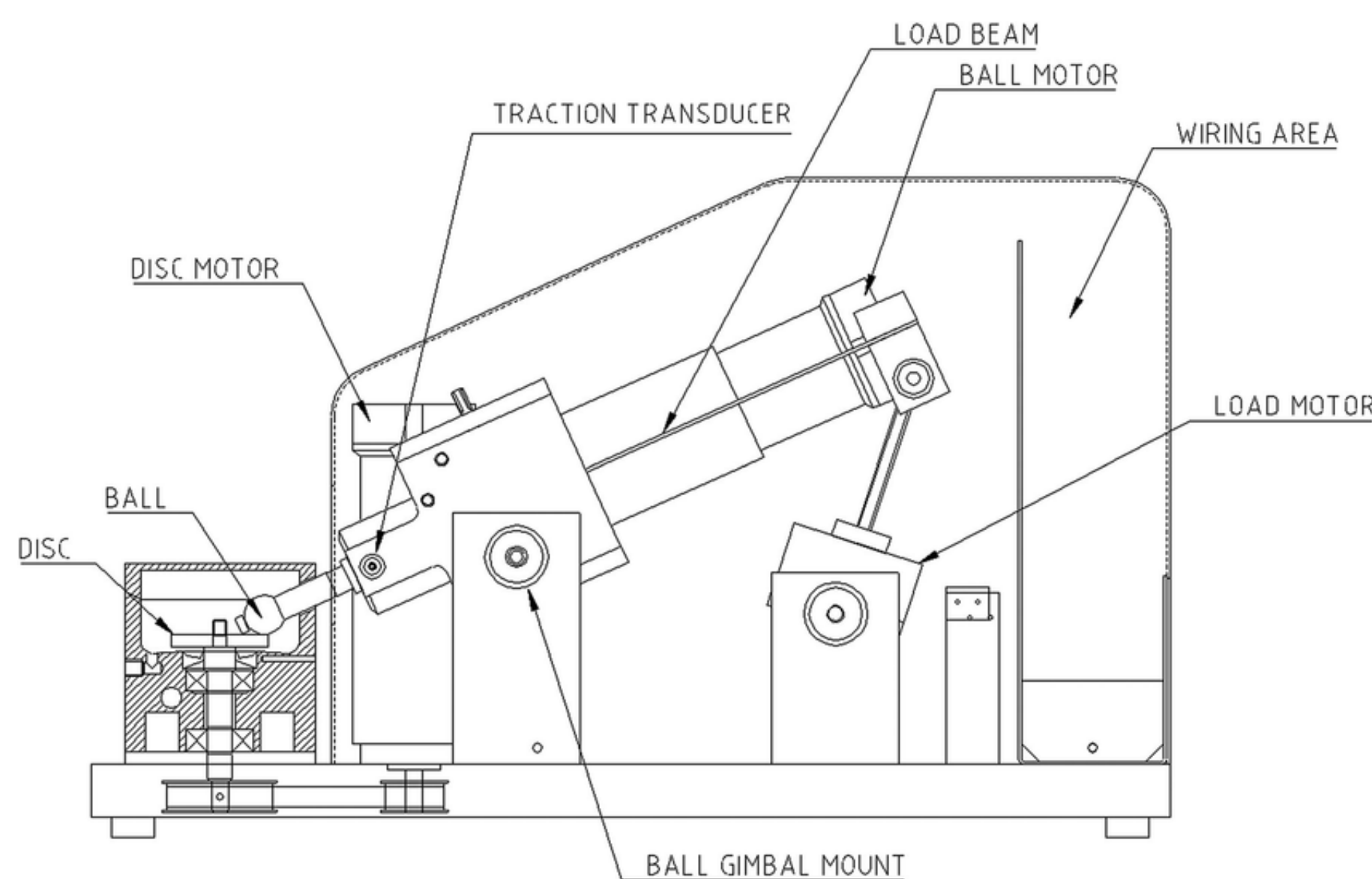


Figure 1: Schematic diagram of the MTM mechanical unit.

- Ball-on-disk geometry, both driven independently.
- Frictional force between the ball and disk are measured by a traction transducer.
- Load is applied by a load motor connected to the load beam.
- Standard configuration: 19.05 mm ball and 46 mm disk (AISI 52100 steel).

Standard operational modes:

- Stribeck measurement: Load, SRR and temperature is set. COF is measured over a range of mean speeds.
- Traction measurement: Rolling speed, load and temperature is set. SRR is varied. SRR from pure rolling to pure sliding (0-200%).

Optional modes:

- Reciprocating option.
- Low load beam option.
- 3D Mapper system.
- ECR option.
- Cooler option.
- Pin-on-disc option.

Results and discussion

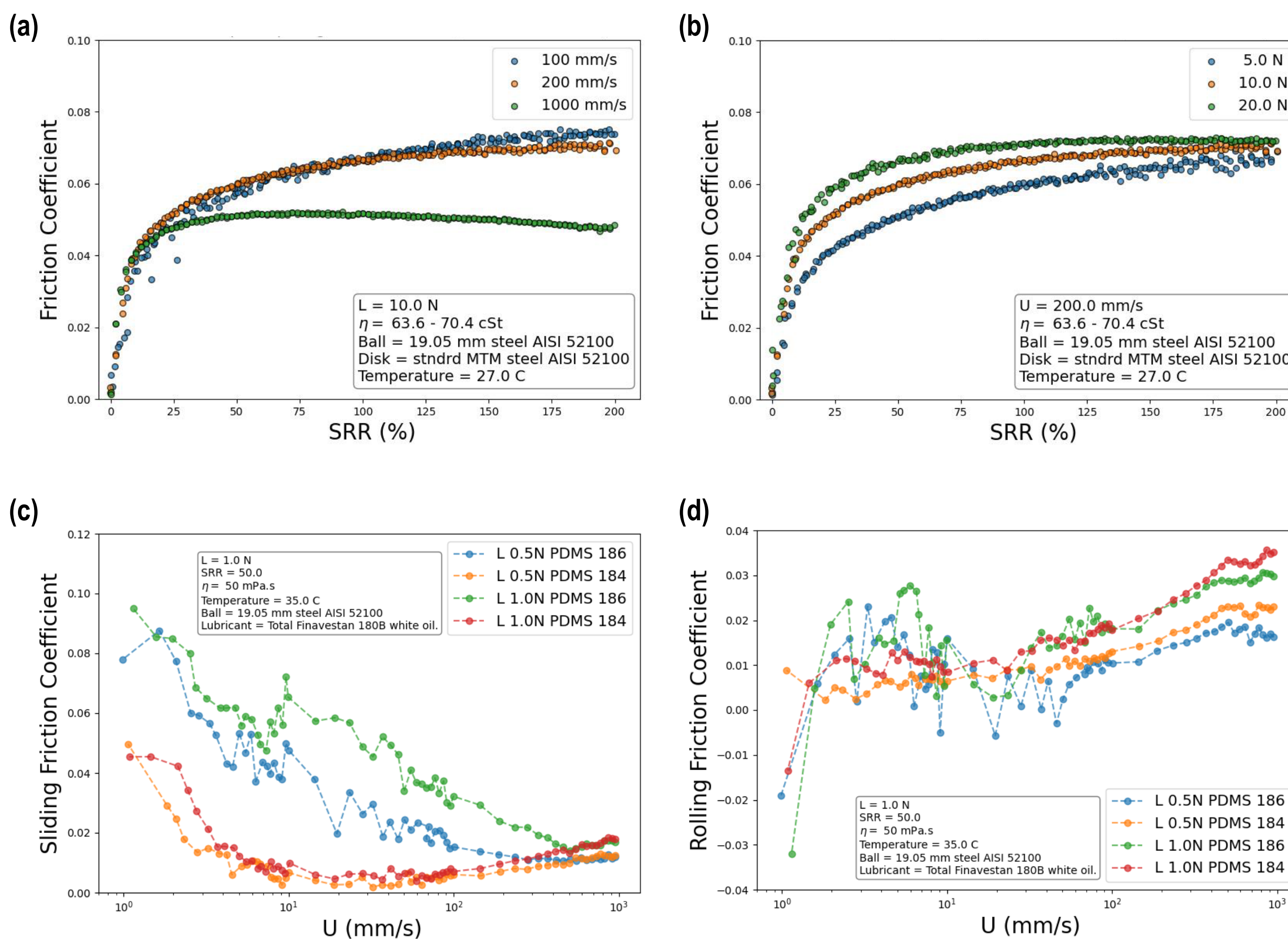


Figure 3: Traction curves at different (a) velocities and (b) loads, lubricant is mineral oil. Stribeck curves showing (c) sliding component and (d) rolling component of friction at different loads and for different materials.

- Traction curves plot friction coefficient as a function of the slide to roll ratio (SRR), providing insight on the frictional behavior of materials in relative motion. This allows for better design of lubricating systems. Useful in predicting friction and wear performance of mechanical components.
- SRR: ratio of absolute value of sliding speed $u_s = |u_b - u_d|$ to entrainment speed $U = (u_b + u_d)/2$, where u_b and u_d are the surface speeds of the ball and disk respectively.
- At low SRR's (see Figure 3a and b) the sliding speed is low. Increase in sliding results in higher strain rate and large shear stresses in the fluid. This leads to the steep increase in friction coefficient seen in the linear region.
- At higher SRR's, high strain rate results in shear thinning. However, the resulting shear stress cannot exceed the critical limiting shear stress value. Thus, the leveling of the curve at the isothermal region.
- A Stribeck curve plots coefficient of friction as a function of the sliding speed, lubricant viscosity, contact pressure and centerline average roughness. The Stribeck curve consists of three main regimes, i. boundary lubrication (BL), ii. mixed lubrication (ML) and iii. (elasto)-hydrodynamic lubrication (EHL).
- Figure 3c and d show the sliding and rolling components respectively, of a Stribeck measurement. At low sliding speeds, the load of the ball is carried by the asperity peaks resulting in a large interfacial shear strength (BL). At high sliding speeds, formation of a continuous lubricant film means the load of the ball is carried entirely by the lubricant (EHL) and is characterized by a lower coefficient of friction which is dependent on the shear stress of the lubricating film.

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