

## Rheometers

## Tribo-rheometry accessories for HAAKE MARS Rheometers

### To determine friction, lubrication, and wear

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#### Introduction

Tribology is the study of friction, lubrication, and wear of surfaces. It plays an important role in many areas of daily life.<sup>1,2</sup> The same applies to rheology, the science of flow and deformation of matter. Modern rotational rheometers are universal laboratory testing devices that allow combined measurements with other analytical methods as well as further investigations beyond pure rheometry. This also includes tribo-rheometry.

A rotational rheometer that is equipped with an automatic lift mechanism for precise axial position control, and can apply defined normal forces during a measurement, can also perform tribo-rheological measurements when using suitable measuring geometries. Tribo-rheometry measuring geometries consist of two contact surfaces that are in contact and move relative to one another. The interaction (friction) of the two surfaces can be measured directly or on the dependence of a friction-changing (lubricating) substance. Typical tribo-rheological measurements include the determination of a coefficient of friction as a function of the relative speed of the two contact surfaces. The data obtained is often presented in the form of a so-called Stribeck curve which is shown schematically in Figure 1. The determined coefficient of friction depends on the experiment parameters (normal force, speed range), the surface materials, the lubricating substance, and the temperature.

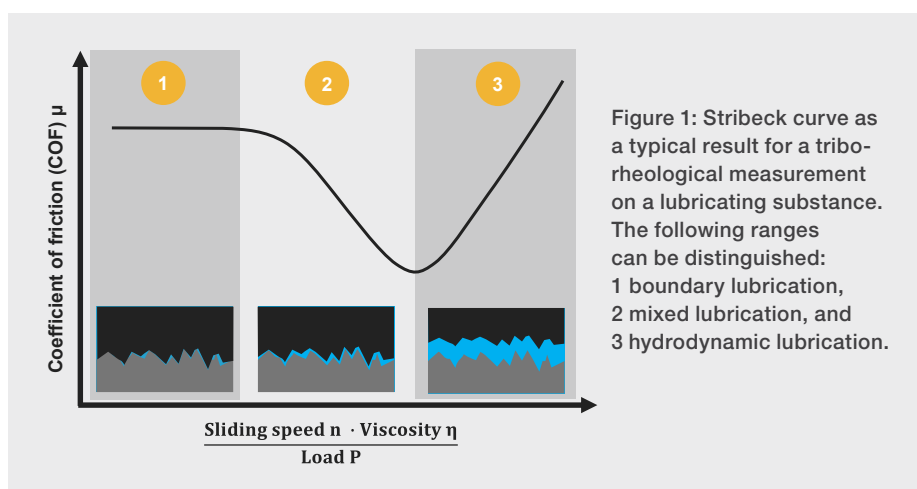
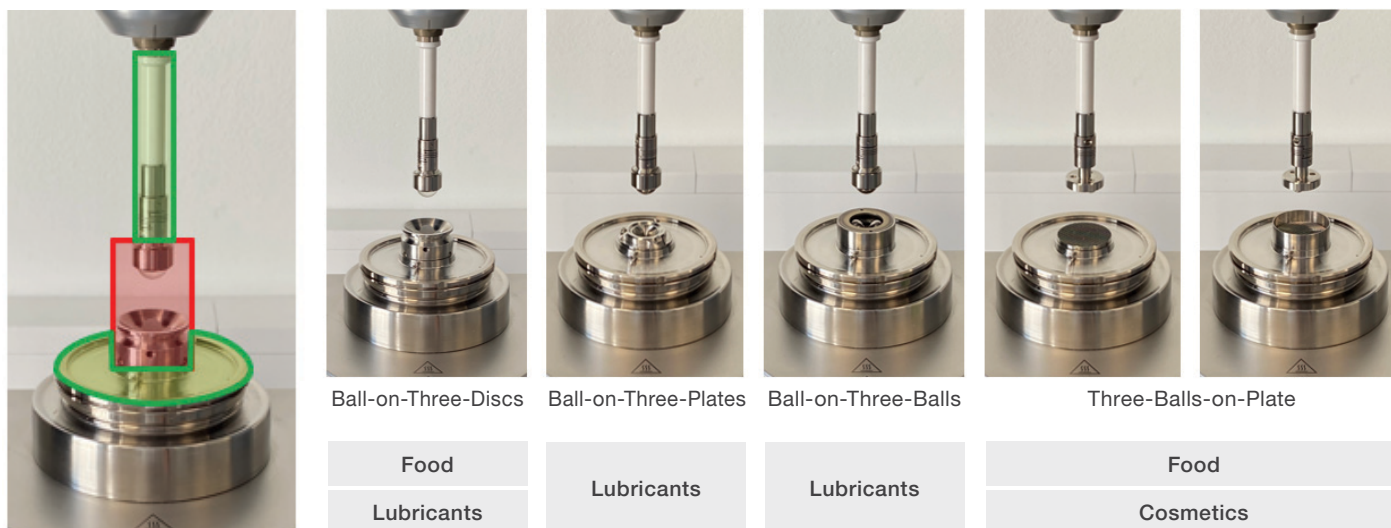


Figure 1: Stribeck curve as a typical result for a tribo-rheological measurement on a lubricating substance. The following ranges can be distinguished: 1 boundary lubrication, 2 mixed lubrication, and 3 hydrodynamic lubrication.



**Figure 2: Left: Modular design of the tribo-rheometry measuring geometry with interchangeable inserts for the rotor and the lower plate. Right: Various combinations and typical areas of application.**

Various tribo-rheometry measuring geometries are available for the Thermo Scientific™ HAAKE™ MARS™ Rheometers. These consist of an upper rotor with quick coupling, automatic recognition (“Connect Assist”), and a flexible spring element that guarantees self-alignment as well as a lower attachment into which a lubricating substance to be measured can be filled. The rotor and the lower attachment are modular, so that various combinations of different geometries (surface alignments) are possible (Figure 2). Balls with diameters of ½” and ¼” made of various materials (steel, stainless steel, ceramic, and glass) are available as contact surfaces for the rotor. The lower attachment can be equipped with contact surfaces in the shape of balls, plates, or discs made of various materials including crosslinked Polydimethylsiloxane (PDMS) for performing soft-tribological measurements on food or cosmetic samples. The following tribo-rheometry

measuring geometries are available as individual configurations: Ball-on-Three-Balls, Ball-on-Three-Plates, Ball-on-Three-Discs, and Three-Balls-on-Plate. For temperature-dependent measurements, the tribo-rheometry measuring geometry can be used with any standard temperature control module for parallel plates and cone & plate measuring geometries and an optionally available sample cover or an active upper-temperature control module. It is also possible to carry out tribological investigations in a temperature chamber (Figure 3),<sup>3</sup> which ensures a homogeneous temperature distribution over a wide temperature range. To be able to react to changing tribological tasks with the greatest possible flexibility, a universal Tribo-Rheometry toolkit is also available. The optional HAAKE RheoWin™ Software Module “Tribo-Rheometry” provides the user with specific tribological parameters as well as a selection of measurement and evaluation routines.



**Figure 3: Temperature-dependent tribo-rheological measurements using the temperature chamber for HAAKE MARS iQ Rheometer series.<sup>3</sup>**

**Ordering information**

Description	Order number
Tribology measuring geometry Ball-on-Three-Discs TR13 B3D (balls: glass, discs: PDMS) for lubricants and food	222-2504
Tribology measuring geometry Ball-on-Three-Balls TR13 B3B (balls: stainless steel) for lubricants	222-2505
Tribology measuring geometry Ball-on-Three-Plates TR13 B3P (balls: stainless steel, plates: stainless steel) for lubricants	222-2506
Tribology measuring geometry Ball-on-Three-Plates TR12 3BP (balls in different materials: stainless steel, glass and ZrO <sub>2</sub> , plate: stainless steel) for food and cosmetics	222-2507
Universal toolbox "Tribo-Rheometry" for maximum flexibility with rotor and inserts for 1 ball ½", 3 balls ¼", lower attachment with inserts for 3 balls ½", 3 plates, 3 discs, two parts sample cover, representative selection of consumables and necessary tools	222-2527
HAAKE RheoWin Software Module "Tribo-Rheometry"	098-5082
Two parts sample cover made from PEEK	222-2526
Spacer ring for using tribology measuring geometries with upper active hood	222-2535
Set of ½" balls (10 pcs.)	
Made from stainless steel (1.4404)	222-2517
Made from steel (1.3505)	222-2516
Made from glass	222-2518
Set of ¼" Balls (10 pcs.)	
Made from stainless steel (1.4404)	222-2519
Made from glass	222-2524
Made from ZrO <sub>2</sub>	222-2525
Discs (30 pcs.)	
Made from steel (1.2210 hardened)	222-2512
Made from PDMS	222-2513
Plates (30 pcs.)	
Made from stainless steel (1.4301)	222-2514

**References**

- Gabriela Saavedra, Measuring meat analog lubricating properties with soft tribology, Thermo Fisher Scientific application report LR94
- Philipp Beutler, The effect of aging on friction, wear, and lubrication of Diesel engine oil during usage, Thermo Fisher Scientific application report V306
- Temperature chamber for HAAKE MARS iQ Rheometer Series, Thermo Fisher Scientific data sheet D038