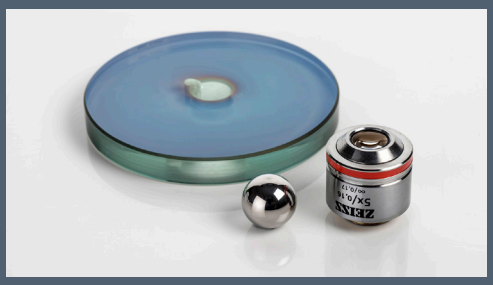
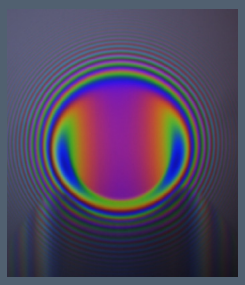
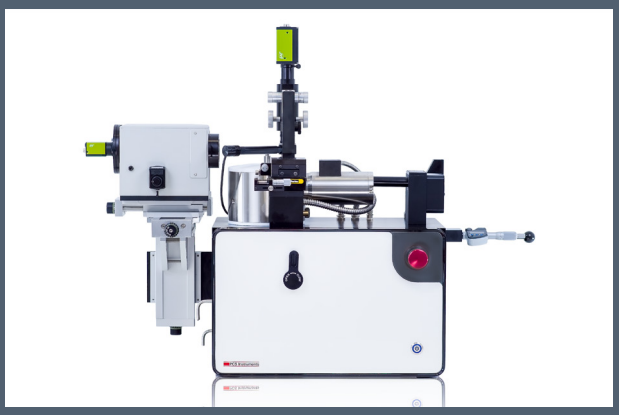
PCS Instruments

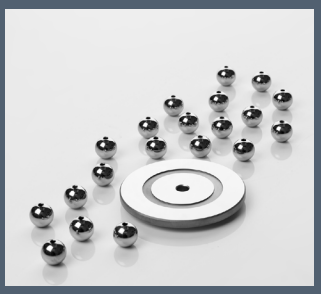
LEADERS IN TRIBOLOGY TEST EQUIPMENT

EHD-HS









A high speed (up to 20 m/s), fully automated, benchtop instrument measuring lubricant film thickness down to 1 nm in the elastohydrodynamic (EHD) lubricating regime.

evolution

EHD-HS Overview

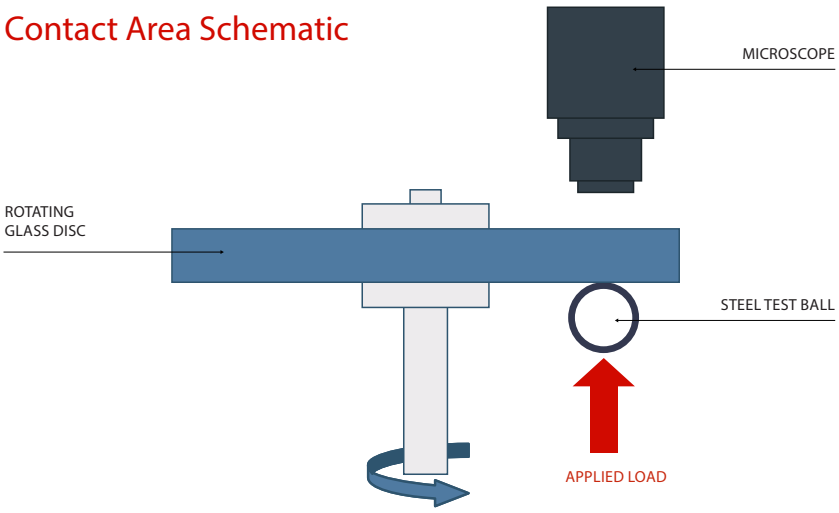
Operating at up to 20 m/s and measuring lubricant film thickness down to 1 nm in the elastohydrodynamic lubricating regime, the EHD-HS represents the forefront of lubricant film testing.

Modern system designs have super finished contacting surfaces allowing them to operate with lubricant film thicknesses below 10 nm and the unique interferometry method used by the EHD-HS enables accurate measurements down to 1 nm, far below the values possible with other measurement techniques.

Upgraded software and mechanical systems make improvements to the instrument's already outstanding reliability and usability. The ability of the EHD-HS to run at speeds up to 20 m/s makes it an ideal choice for researchers studying high speed applications such as electric vehicle drivetrains, and for those studying the effect of additives in automotive lubricants, metalworking fluids, emulsions, turbine oils and greases.

In addition to film thickness measurements, traction coefficients can be measured at any slide/roll ratio from pure rolling up to pure sliding.

Contact Area Schematic

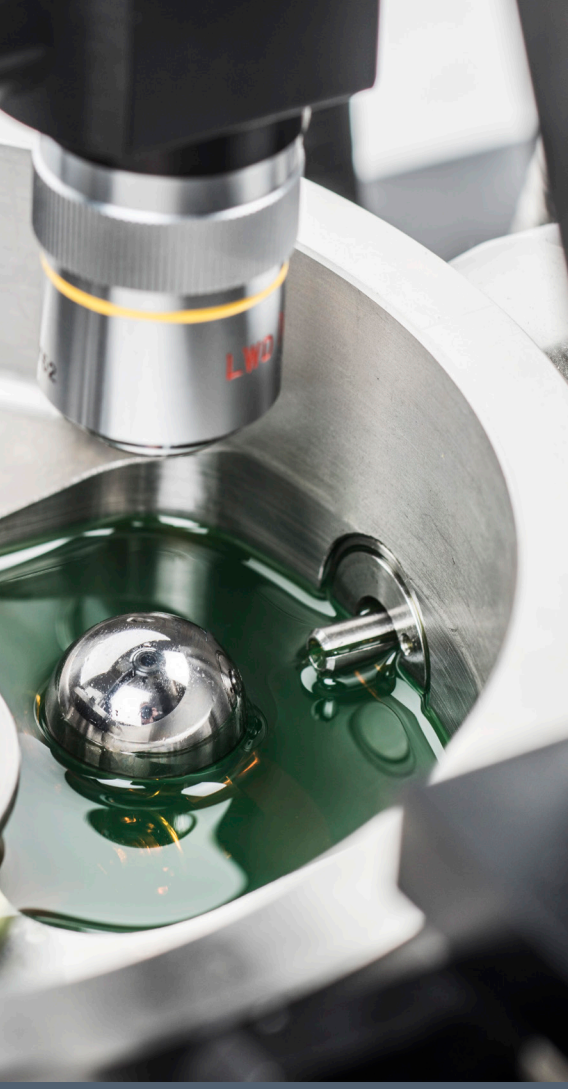


Principle

A steel ball is loaded against a rotating spacer layer disc. The ball and disc are driven by high-speed brushless motors, and the contact is illuminated by a white light source directed down a microscope through the disc on to the contact. Part of the light is reflected from the Cr layer and part travels through the SiO2 layer and fluid film and is reflected back from the steel ball. Recombining the two light paths forms an interference image which is passed into a spectrometer and high-resolution monochrome CMOS camera. The camera image is then analysed by the control software to determine the film thickness.

Applications

- Electric vehicle gearboxes and powertrains
- Low viscosity fluid film formation at high speeds
- Jet engine gearbox and bearing lubrication investigations
- Spindle bearing lubrication investigations
- Film forming properties of novel custom lubricants
- OEM lubricant specifications
- Development of new lubricant additives for high speed applications



Specimens

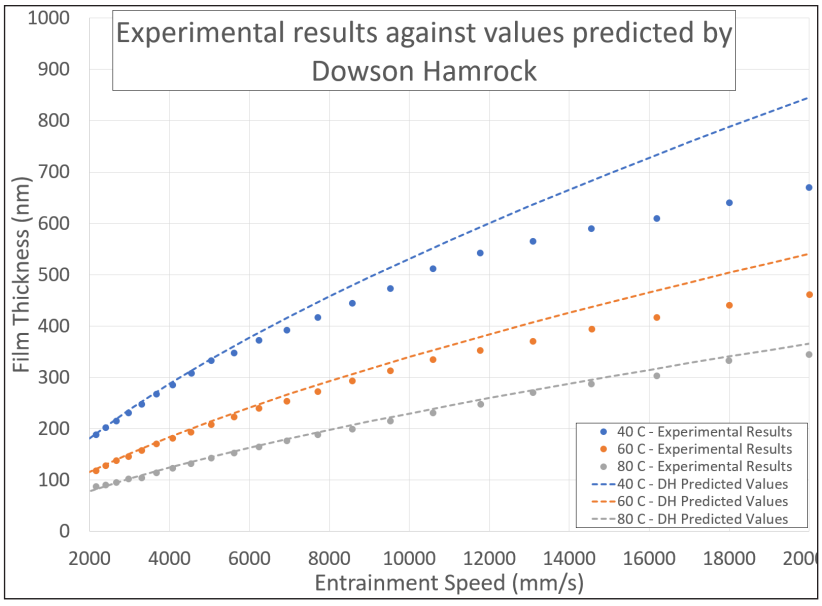
The ¾" diameter plain standard ball is made from carbon chrome steel and has a high-grade surface finish to ensure good reflectivity. The standard glass disc is coated with a semi reflective layer of chromium and approximately 550 nm of silica. A drilled ball can be used which can be driven during the test at a set slide/roll ratio. While the ball must be reflective, it can be made from different materials. We supply tungsten carbide balls (both plain or drilled) and sapphire discs to enable contact pressures up to 2 GPa.

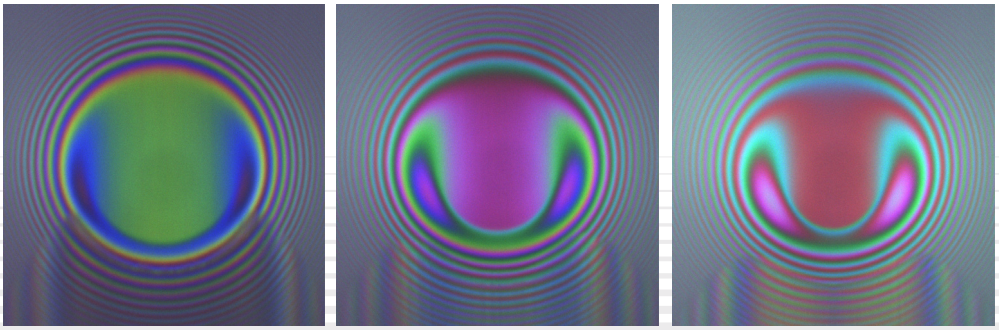
Features and Benefits

- Capable of running at speeds of up to 20 m/s, ideal for high speed applications such as electric vehicle drivetrains
- State of the art software and mechanical system that ensures reliability, repeatability and usability
- High sensitivity cameras for impressive image quality
- Precision components enable accurate measurements down to 1nm
- Two independently driven motors allow any slide/roll ratio to be achieved, enabling many applications to be replicated
- Requires a small sample volume, minimising wastage and cutting running costs
- Fully automated and easy to calibrate, with intuitive software, reduces training needs
- Compact and ergonomic design to minimise required lab space

High Speed EHD Films

At very high speeds, EHD films have been shown to be significantly thinner than predicted by the empirically derived Dowson and Hamrock equation (Hili et al. in 2010). The reduced film thickness is caused by a combination of inlet shear heating and kinematic inlet starvation, the combination of which is difficult to predict theoretically. The EHD-HS facilitates straightforward, accurate and repeatable measurement of EHD film thicknesses at speeds of up to 20 m/s. This allows users to improve their models, perform realistic and representative tests at application appropriate speeds, and to develop a deeper understanding of the performance of their lubricants.





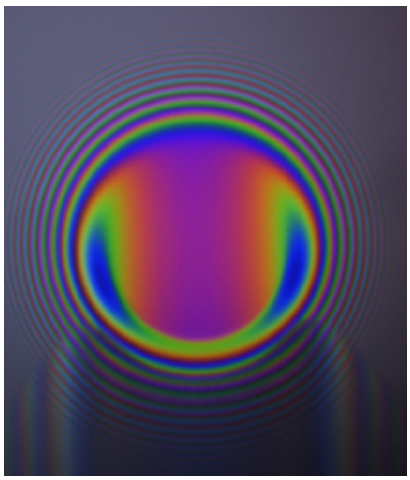
EHD SLIM images of films at 40 °C at 2000, 9000 and 20000 mm/s

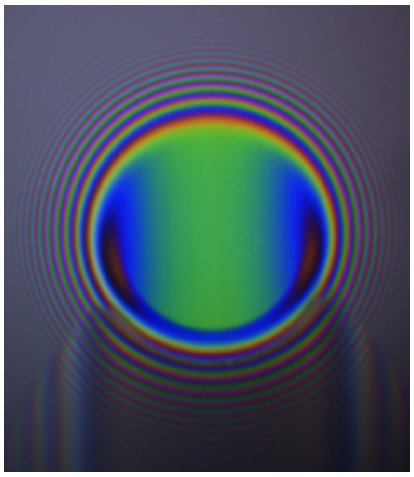
EHD-HS Option: Spacer Layer Imaging Method (SLIM)

Instead of using a spectrometer to determine the wavelength of the light returned from the image of the EHD contact, the innovative Spacer Layer Imaging Method - or SLIM - uses a high resolution, RGB colour camera to grab an image of the whole contact.

Developed by PCS, the SLIM software uses a previously determined colour space calibration to match the colours in the image to oil film thicknesses. The system can produce a film thickness map of the whole EHD contact in only a few seconds, making it a unique and easy-to-use tool for examining conditions such as parched or starved lubrication, grease lubrication, and rough surface EHD.

The enhanced camera attached to the EHD-HS comes with shorter exposure times and a higher sensitivity sensor, meaning it is still possible to capture clear EHD contact images at the higher speeds capable on the EHD-HS.





SLIM Software

The control software for the SLIM system allows the user to conduct a test on the EHD-HS system and acquire images of the contact under user-defined test conditions.

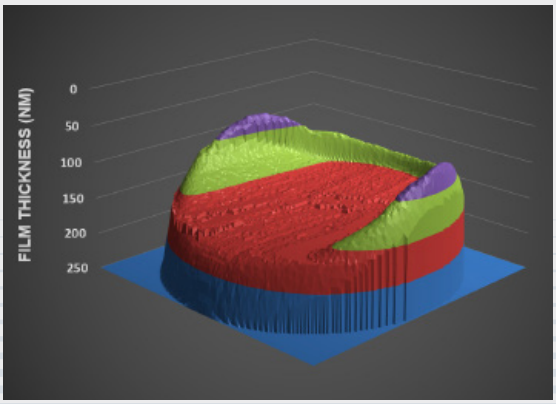
Once the test is completed, the images are analysed using a stand-alone analysis program. The analysis program matches colours in the image to the calibration data supplied with the instrument to determine the film thickness at every point in the image up to a maximum film thickness of approximately 250 nm. This allows the user to generate a complete film thickness map of the contact area or point and line measurements of a specific area of interest. The analysis program writes out the film thickness data as a text file, which can then be loaded into a suitable graphical spreadsheet package.

Pressure Viscosity Coefficient

The pressure viscosity coefficient is a fundamental fluid property which controls the lubricant film thickness in an EHD contact. Although it is possible to measure the pressure viscosity coefficient of a lubricant using high pressure viscometry, this can be both difficult and time consuming. A simpler method is to calculate a representative value by measuring the EHD film thickness and then determining the effective pressure viscosity coefficient using a known reference oil. The EHD-HS can perform this method according to the SAE ARP 6157 standard.

The AVA program is a software tool which automates EHD-HS test profile generation and subsequent data analysis, as well as managing the calibration of the software using an EHD-HS instrument and a well-defined reference fluid, available from PCS Instruments. This eliminates the need for any manual calculation or user intervention, greatly simplifying the process.

EHD-HS SLIM 3D film thickness measurement



EHD-HS Accessories

To further expand the capabilities of the EHD-HS, we have developed a range of additional accessories, some of the most popular accessories are shown below.
All accessories can be easily retrofitted to the instrument.

Grease Scoop

The optional grease scoop consists of a PTFE block supported in a stainless steel pillar that is attached to the ball carriage. The PTFE block has a channel which guides the grease into the contact, ensuring a constant supply of grease through the test.

Fluid Extraction System (FES)

A sleek, stand-alone accessory designed for the quick, safe removal of lubricants and cleaning fluids after each test. Operated by the push of a button, the FES drains the lubricants used in a test, and any subsequent cleaning solvents used; facilitiating a much faster and simplified cleaning process.

Cooler

An optional cooler can be connected which circulates silicone cooling oil through the cooling ports in the pot. This allows for a quicker turn-around of tests. The EHD cooler integrates with the instrument's software, automatically switching on the cooler at the end of a test and cooling the pot down to a pre-defined temperature.

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EHD-HS

Technical Specification

The EHD system comprises separate electronic control and mechanical units and a PC with custom control software.

TEST PARAMETERS	
Film Thickness	1 nm to 1000 nm
Load	2 to 50 N
Contact Pressure	0.24 to 0.7 GPa (Steel ball on glass disc) 0.66 to 2.0 GPa (Tungsten carbide ball on sapphire disc) 0.38 to 1.1 GPa (Steel on steel contact)
Speeds	Up to 20 m/s
Temperature Range	Ambient to 150 °C
Test Sample Volume	120 ml

CONTROL SYSTEM	
PC	Custom software running on Microsoft Windows
Safety Checks	Dual platinum RTDs for temperature measurement, emergency stop on front cover, lid locking tool
Power Supply	100-240 V, 50/60 Hz, 750 VA

DIMENSIONS & WEIGHT	
Weight	(Mechanical Unit) 51 kg / 112 lb (Electronics Unit) 8 kg / 17 lb (Power Supply) 10 kg / 22 lb
Size (h x w x d)	(Mechanical Unit) 750 mm/30 in x 1100 mm/43 in x 350 mm/14 in (Electronics Unit) 400 mm/15.8 in x 150 mm/6 in x 360 mm/14.2 in (Power Supply) 400 mm/15.8 in x 150 mm/6 in x 360 mm/14.2 in

Industries

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