Press Release

Fraunhofer IST is developing innovative thin-film sensor technology for axial piston pumps as part of the "ThinSor" project

Ultra-thin sensor makes the invisible measurable

In axial piston pumps, performance is often determined in a place that cannot be seen with the naked eye: between the rotating cylinder barrel and the stationary valve plate. An ultra-thin lubricating film ensures that the components interact with as little friction as possible. But what exactly happens at this highly stressed contact point during operation? Together with research partners, the Fraunhofer Institute for Surface Engineering and Thin Films IST aims to investigate these processes in greater detail. The "ThinSor" project aims to develop thin-film sensor technology capable of measuring temperature, pressure, and lubricating film thickness directly at the contact point.

The conditions within the lubrication gap significantly influence a pump's efficiency, service life, and reliability. Until now, however, direct measurement of temperature, pressure, and lubricating film thickness in this area has been limited. Conventional measurement methods often require drilling or other component modifications that can affect the contact behavior and, consequently, the measurement itself. "ThinSor" is now taking a different approach: a sensor layer system just a few micrometers thick is applied directly to the surface of the control disc. This should enable all three parameters to be measured simultaneously and with high temporal resolution exactly where they occur – without the need for time-consuming post-processing of the component.

The measurement data obtained is intended to help design fluid-technology components more precisely and to validate simulation models and digital twins. The goal is to make development processes more efficient and reduce development iterations, thereby minimizing the number of prototypes required. Small and medium-sized enterprises (SMEs), in particular, could benefit from improved capabilities for analyzing and optimizing their components. When designed for the entire service life, the sensor technology also supports condition monitoring of new and existing pump systems. Critical operating conditions and wear can be detected early, maintenance measures can be better planned, and unplanned downtime can be reduced.

Sensor Technology for Demanding Operating Conditions

A key challenge for Fraunhofer IST is the reliable measurement of comparatively low pressures at the high-stress contact point between the piston drum and the control disc. At less than 50 MPa, these pressures fall below the pressure ranges for which existing sensor solutions are

typically designed. The pressure sensors must therefore be adapted so that the relevant measurement signals can be reliably distinguished from the background noise. At the same time, the thin-film sensor system must withstand the high mechanical stresses encountered during operation.

The project partners are working closely together on development and testing. While Fraunhofer IST continues to refine the pressure sensor technology, the partners are investigating contact behavior, testing the sensors on an actual pump, and validating measurements against simulations. The goal is to lay the groundwork for making these measurement methods suitable for industrial applications.

Beyond axial piston pumps, thin-film sensor technology could also be used in other machine components in the future. Applications involving bearings, gears, and shafts already demonstrate the potential of this technology. In the long term, it can help continuously monitor components, detect wear at an early stage, and plan maintenance measures proactively. Reliable measurement in lower pressure ranges could also open up new fields of application.

About the Project

"In-situ Thin-Film Sensors for Measuring Temperature, Pressure, and the Lubricating Film Thickness Between the Cylinder Barrel and the Valve Plate," or "ThinSor" for short

Project partners:

- Fraunhofer Institute for Surface Engineering and Thin Films IST
- Institute for Fluid-Powered Drives and Systems (ifas), RWTH Aachen University
- Chair of Machine Elements and Tribology (LMT), University of Magdeburg

Project duration: June 1, 2026 – November 30, 2028

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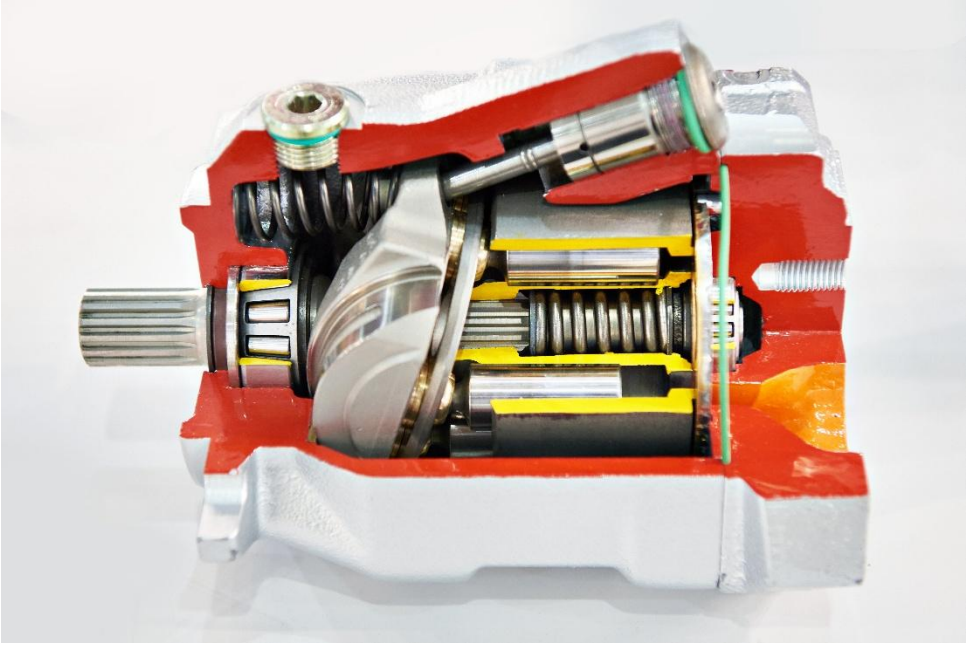


Fig. 1 Example of an axial piston pump, which is the focus of the "ThinSor" research project. © Sergey Ryzhov, adobe.stock.com

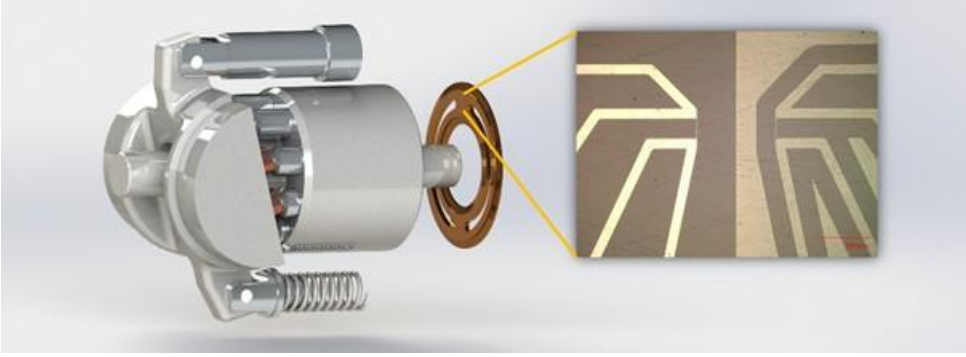


Fig. 2 The thin-film sensor system is applied directly to the surface of the valve plate. The microscopic image shows a thin-film pressure and temperature sensor that is being further developed in the "ThinSor" project for use in the highly loaded pump contact. © Fraunhofer IST

The Fraunhofer Institute for Surface Engineering and Thin Films IST is an innovative partner for research and development in surface technology, with expertise in the associated product and production systems. The aim is to develop customized and sustainable solutions: from prototypes, through economic production scenarios, to upscaling to industrial magnitudes – and all this whilst maintaining closed material and substance cycles. The Fraunhofer IST is one of the seventy-five institutes of the Fraunhofer Society, one of the world's leading organizations for applied research.

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