

Tactile sensor interprets stress distribution and magnitude in O-rings and gaskets

By Roy Szweda, Contributing Editor

In the May issue we looked at an important new tool for the examination of seal integrity, where Tom Adams reported on acoustic imaging of seals in medical cartridges. In this issue we stay with the measurement of sealing performance, with coverage of a newly updated system which assesses pressure and hence seal characteristics. Topaq® is a revolutionary stress measurement instrument for analysing force distribution and magnitude.

Made by Sensor Products Inc of East Hanover, New Jersey, the Topaq® Pressure Analysis System is broadly applicable wherever pressure is of interest. However, here we look at its use for O-rings and gaskets, and show how useful it can be for the assessment and proving of sealing technology.

Sensor Products is a leading designer and manufacturer of sensor systems exclusively for tactile pressure monitoring and analysis. The company draws on some 10 years of experience to continuously extend the capabilities of tactile pressure management. With the introduction of Topaq, engineers now have an affordable tool of great power and accuracy. The system improves yield, ensures parallelism, registers the precise characteristics of an impact, validates press uniformity and aids in all types of machine calibration, in both R&D or quality assurance.

Unlike finite-element analysis (FEA), Topaq is a post-process interpretive system that collects data from a proprietary tactile transducer. The system consists of a specially calibrated densitometric scanner and Windows software. An essential component of the system is the force-indicating film, known as Pressurex® or Fuji Prescale®. These sensor films change colour permanently and instantaneously in response to applied pressure. The scanner and software are

then used to image and interpret the stress marks on the film. From this, the system renders high-resolution, colour-calibrated images and a wealth of statistical information pertaining to the analysed film.

Used in conjunction with Pressurex/Fuji Prescale stress-indicating films, Topaq provides a unique perspective of the distribution and actual magnitude (in psi, for example) of pressure between any contacting or impacting surfaces. For example, the system is proving very popular for automotive applications, and has been used to test crash test dummies, for example. By placing Pressurex film on the impact points, the system can be used to provide quantitative information as to where the greatest force occurs and what type of force is being experienced.

Mylar pressure-sensitive films

The sensor film comes in the form of an ultra-thin page-sized sheet of micro-encapsulated Mylar®. When placed between interfacial surfaces, Pressurex changes colour. The intensity of this colour is proportional to the amount of torque applied, allowing quantification of the stress characteristics across the surface of the film. Precise

indications of pounds per square inch can be determined by comparison of the film's resultant colour change with a colour calibration chart (similar to interpreting litmus paper), or by using one of several imaging systems from Sensor Products.

Pressure-indicating sensor film has been around for several years. It quickly, accurately and inexpensively identifies how force is disbursed at the interface of any two contacting or mating surfaces. Pressurex is proving to be a valuable aid for applications such as validation and calibration of sealing die pressure during food and drug packaging. In aseptic packaging systems such as controlled atmosphere packaging (CAP) or modified atmosphere packaging (MAP), Pressurex aids in fulfilling good manufacturing practice (GMP) compliance by revealing weak spots, channels and wrinkles at the sealing surface.

Pressurex is very thin (4–8 mil, or 100–200 µm), which enables it to conform to curved surfaces, and it is ideal for invasive-intolerant environments and tight spaces. To use, Pressurex film is simply placed between any two surfaces that will touch, mate or impact. It immediately reveals the pressure distribution profile that occurs between the surfaces. The colour intensity of the film is directly related to the amount of pressure applied to it, so the greater the pressure, the more intense the colour.

Used in conjunction with Pressurex pressure indicating films, Topaq provides a quick, yet thorough analysis of the pressure distribution and magnitude between any two surfaces that

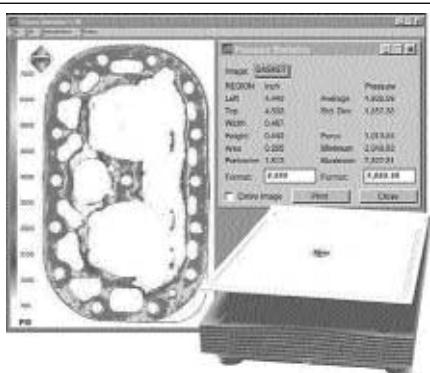


Figure 1. Topaq® image of a gasket, showing how the scanner and software system renders high-resolution, colour-calibrated images and a wealth of statistical information pertaining to the analysed film.

come into contact. This system renders high-resolution, colour-calibrated images that accurately reflect how force is disbursed in the application in question. The system consists of a specially calibrated scanner, and software.

Pressurex is used to verify and record pressure distribution during equipment set-up, preventive maintenance and product changeover for various form/fill/seal, deposit/fill/seal and CAP/MAP systems.

Another useful application has been in package drop test measurement, for example in the measurement of roller pressure in the embossing and gravure processes, or measuring interface pressure during ultrasonic

welding, and taking nip impression between rollers.

Quality control and R&D

Topaq can also be used in quality control and in research and development, in applications where it is required to monitor and ensure proper force distribution in any situation where two objects are pressed or formed together, with an accuracy of $\pm 4\%$. For example, it can be used to analyse flange and gasket interface pressure profiling on any compressor, pump or motor, thereby helping to ensure O-ring seal efficacy.

The system can also analyse pressure tests on both bolting patterns and the number of bolts required to achieve satisfactory sealing efficacy across gasketed interfaces.

Recent improvements in the Topaq software include histograms of pressure levels, enlargement and reduction capabilities, pseudo-colour and 3D viewing modes and extensive smoothing, filtering and thresholding. Surface contact areas down to 3 mils (75 μm) can be analysed. Each image and its accompanying statistics can be saved, printed and exported for analysis in other software packages.

Grid-maker functionality

Topaq's Grid-maker function divides image into any number of user-defined quadrants. The

software then automatically calculates statistical information for each segment, and can also assimilate it in an easy-to-read format. Histograms are easily generated, to reveal the statistical distribution of pressure levels throughout the image, or on a user-defined region of interest.

Application images can be viewed, rotated and flipped in two- or three-dimensional space, and images can be further enhanced by varying the number of colours displayed or by utilising powerful smoothing and thresholding functions.

The system allows images to be expanded or reduced, and its manual and auto-cropping features allow quick slice-off of extraneous parts of an image, enabling detailed examination of a specific region of interest. The Duplicate Zoomed Image function uses a proprietary algorithm to enlarge an image without the typical accompanying increase in graininess.

An example of Topaq's powerful, single-keystroke features is the ability to determine the pressure profile along a user-defined line. This line can be reduced to the width of a pixel, or expanded as wide as the image itself. This is a useful tool for assessing narrow bands of pressure over unusual or intricate shapes. The region statistics function yields total force, average psi (or kg/cm^2) and standard deviation for the entire image or a user-defined region.

Micro-imaging system

The Pressurex-micro Imaging System produces a high-resolution, full-colour representation of pressure distribution. The mat is placed between any two contacting or impacting surfaces. On removal it immediately reveals a grey-scale pressure distribution profile. The colour intensity of the resulting image reveals the relative amount of applied pressure. The system's software renders information into a clear, easily interpreted image in seconds.

The Pressurex-micro Imaging System is claimed to be an easy, effective way to determine pressure distribution between mating surfaces. It was designed with low contact pressure in mind – ideal for any load less than 20 psi (1.5 kg/cm^2). Ideal applications include gauging lamination press parallelism, ensuring sealing efficacy, examining tyre tread footprints and observing various ergonomic impacts.

For more information, contact: Sensor Products Inc, 188 Route 10, East Hanover, NJ 07936, USA. Tel: +1 973 884 1755, Fax: +1 973 884 1699, Email: sales@sensorprod.com, http://www.sensorprod.com

Physical specifications:

Temperature range	5–35°C (41–95°F; higher for brief exposure)
Humidity range	20–90% RH
Gauge	4–8 mil (0.1–0.2 mm)
Spatial resolution	5–15 μm
Substrate	Polyethylene terephthalate (PET)
Accuracy	$\pm 10\%$ visual ($\pm 1\%$ using optical measurement system)
Shelf life	2 years

Examples of industrial applications:

- Aerospace composites/materials testing
- Plastics and metals nips, presses, laminations
- Electronics transistor mounting, tape automated bonding (TAB), liquid crystal displays (LCDs)
- Medical ultrasonic welding, heat sealing
- Packaging heat sealing
- Automotive gasketing, canning
- Papermaking converting

Physical specifications and industrial applications of the Topaq system.