QUANTUM Terahertz
Terahertz wall thickness measurement in the plastics industry
For some years INOEX GmbH has placed a special focus on the development and sales of Terahertz wall thickness measuring systems for the plastics industry and can rightfully call itself the pioneer for this key technology. INOEX has since pursued this course and QUANTUM technology has been taken to the next level. This was made possible thanks to the special penetration properties of THz waves and the fact that T-rays are harmless to human beings. Probably the most well-known example for non-destructive material testing by means of Terahertz is the quality inspection process on the plastic insulation of the Space Shuttle. Moreover, the technical progress made during the past years in electronics and optics has produced increasingly powerful THz transmitters and receivers which prepared the way for an economic usability of Terahertz waves for wall thickness measurement in the plastic pipe extrusion industry.

The production of plastic pipes is largely determined by the high demands on quality control, economic efficiency and productivity levels. These demands can be met only by up-to-date automation concepts. The other important feature is the user friendliness of such measuring and automation systems.

The QUANTUM product line solves almost all measuring, automation and documentation tasks for single-layer pipes or co-extruded pipes while offering customized process solutions for very specific pipes. Of particular interest is the easy operation of all QUANTUM systems. This includes, above all, the easy operation of the software, the temperature-independent measuring principle, the automatic centering of the measuring mechanics and the fact that THz sensors focus automatically.

QUANTUM 360 and its reversing THz sensor cover a broad product spectrum. A process-oriented measuring mechanics which centers automatically, combined with gravimetric measurement and control, thermal centering and further modules provide an end-to-end solution for the automation of pipe extrusion lines. And all that at a good price-performance ratio.

"QUANTUM is the most versatile Terahertz wall thickness measuring system currently available in the plastics industry. It can solve almost any measuring task related to wall thickness sizes. Together with gravimetric mass throughput control or weight per length control, QUANTUM is able to achieve a higher productivity at lower cost."

Ralph Klose
Director Technology
QUANTUM - THE NEW MEASURE OF WALL THICKNESS MONITORING

QUANTUM 360

The sensor of QUANTUM 360 reverses 360° around the pipe. It offers a high-precision wall thickness measurement from 100 µm to 2.36" (60 mm)\(^1\). The automatic centering by way of an electrically driven XY cross table and the automatic focus setting allow a fully automated operation.

Absolute measurement of 360°\(^1\)

\(^1\) depending on material types and applicable measuring methods

QUANTUM CP

QUANTUM CP is the first wall thickness measuring system for corrugated pipes. Wall thickness sizes and diameters of crown, valley, spigot and bell are measured around 360°.

360° measurement of corrugated pipes!

QUANTUM BM

QUANTUM BM - the first wall thickness and diameter measuring system for blow moulding. Inline measurement of wall thickness sizes and diameters of the melt flow. Offline measurement of the wall thickness on the ready product.

Inline and offline wall thickness measurement for blow moulding!

QUANTUM FILM

QUANTUM Film convinces due to its highly precise wall thickness measurement in cast film extrusion.

The perfect solution for cast film!
STATE-OF-THE-ART TECHNOLOGY AND A MAXIMUM MEASURING ACCURACY!

Only a steady, continuous and overall stabilization of the extrusion process allows an efficient line production and thus ensures competitiveness in the plastics market. This requires a technology which is able to master the required decisive functions “measurement & control” and the related documentation.

Against this background the next generation of QUANTUM has been developed. This tried and tested system features a Terahertz sensor which reverses or traverses along the measured product. The reversing or traversing of the sensor provides a highly precise overview of all parameters of the manufactured product. In the blow moulding process a robot arm frequently positions the finished product in front of a static QUANTUM Terahertz sensor where several measuring spots of the blow moulded product are inspected.

The high flexibility of the QUANTUM Terahertz system allows for customized solutions. A high measuring sequence frequency of min. 100 Hz and the large measuring range for wall thickness sizes from 25 µm to 2.36" (60 mm) cover a wide spectrum of potential customer demands.

ELECTROMAGNETIC SPECTRUM

- Dependent on material types and applicable measuring methods.
ABSOLUTE MEASUREMENT AROUND 360°!

NEXT GENERATION.

QUANTUM 360 is a systematic further development. A special focus was put on user friendliness. The multi-touch surface convinces with its intuitive interface. Owing to the temperature-independent measuring process, all which remains to do for the line operator is to select the pipe recipe. QUANTUM 360 detects the pipe position and centers automatically by way of an XY cross table. Then the Terahertz sensor is automatically focussed in the center by two spindles. There are no dimensioned component parts involved. When product dimensions are changed, only the pipe recipe needs to be changed.

All movable parts are located inside the housing of QUANTUM 360. An open adapter establishes the mechanical connection between QUANTUM 360 and the vacuum tank. Its design requires a minimum of space in extrusion direction. All electronic parts are built to protection class IP 65 to protect QUANTUM 360 from occasional splash water. As far as the design is concerned, particular attention was given to low maintenance of all mechanical and electronic components.

COMPLETE AUTOMATION CONCEPT.

In combination with a gravimetric system, QUANTUM 360 can be set up as a complete automation system for your extrusion line. By way of a systematic start-up process, a better pipe centering, weight per length control and thin point control, material savings of up to 5 % or more can be achieved.

<table>
<thead>
<tr>
<th>Type</th>
<th>Pipe OD (mm)</th>
<th>Pipe OD (inch)</th>
</tr>
</thead>
<tbody>
<tr>
<td>QUANTUM 360 / 250</td>
<td>42 - 250</td>
<td>1.66 - 9.84</td>
</tr>
<tr>
<td>QUANTUM 360 / 400</td>
<td>63 - 400</td>
<td>2.48 - 15.75</td>
</tr>
<tr>
<td>QUANTUM 360 / 630</td>
<td>90 - 630</td>
<td>3.54 - 24.80</td>
</tr>
<tr>
<td>QUANTUM 360 / 1000</td>
<td>250 - 1000</td>
<td>9.84 - 39.37</td>
</tr>
</tbody>
</table>

MEASUREMENT, CONTROL AND EVALUATION BY QUANTUM 360:

- Reversing wall thickness measurement around 360°
- Diameter measurement in 120 position
- COEX measurement
- S-min control (without gravimetry)
- Alarm handling
- Optional: documentation and inoTREND
- When combined with gravimetry:
  - Control of thin points
  - Mass throughput control
  - Weight per length control via haul-off unit or extruder
  - Wall thickening
  - Guide parameter control
  - Bleeding function

BENEFITS:

- Detailed information about your product, resp. wall thickness sizes, diameters, eccentricity and ovalness
- Absolute measurement
- Automatic centering, accuracy ± 1.97° (50 mm)
- Automatic focusing
- COEX measurement
- Independent of temperature
- Electronic parts according to IP 65
- Material savings of 5 % or more through:
  - S-min or thin points control
  - Better centering
  - Systematic start-up
  - Weight per length control
- Simple operation
- Proven control principles
EXCEPTIONAL SAVINGS.

**QUANTUM CP** is the first automation system for larger-sized corrugated pipe extrusion lines. It is for the first time that one system is able to measure inline around 360° the wall thickness and diameter of the crown, valley, bell and spigot of a corrugated pipe. When this system is operative together with a gravimetric system, material savings of 5% or more become possible.

HOW IT WORKS.

**QUANTUM CP** features a reversing Terahertz sensor which is mounted on a movable slide. If for example the bell to be measured has reached the Terahertz sensor, **QUANTUM CP** shortly speeds up and synchronizes with the line speed of the corrugated pipe via two clamps. Then, the sensor reverses around the bell by a full 360°. With the help of the opposing laser sensor and the Terahertz sensor the exterior diameter is equally measured. Subsequently, the clamps are released and **QUANTUM CP** moves back to its start position. The next measuring cycle is started subsequently to measure a crown, valley, bell or spigot.

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### BENEFITS:

- Detailed information on your product (wall thickness, diameter)
- Direct measurement independent of temperatures
- Material savings of 5% or more due to better centering, systematic start-up and weight per length control
- Optimum support for the operator
- Documentation for submission to the customer
- Proven control principles

### 360° MEASUREMENT:

- Crown: interior and exterior diameters, air gap between walls, interior and exterior diameters
- Valley: wall thickness
- Spigot: wall thickness and exterior diameter
- Bell: interior diameter and wall thickness

### MEASUREMENT, CONTROL AND EVALUATION BY QUANTUM CP:

- Wall thickness and diameters around 360°
- 360° wall thickness measurement, reversing
- Diameter measurement in up to 60 axes
- Alarm handling
- Documentation and iTOREND
- When combined with gravimetry:
  - Mass throughput control
  - Weight per length control via extruder

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<table>
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<tr>
<th>Type</th>
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<th>Pipe OD [inch]</th>
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<tr>
<td>QUANTUM CP / 630</td>
<td>250 - 630</td>
<td>9.84 - 24.80</td>
</tr>
<tr>
<td>QUANTUM CP / 1000</td>
<td>400 - 1000</td>
<td>15.75 - 39.37</td>
</tr>
</tbody>
</table>
QUANTUM is a universally applicable system due to its high flexibility. Customized solutions for blow moulding, for both inline and offline measurement are already in service.

FIRST INLINE WALL THICKNESS MEASUREMENT.

When used for inline operation in a blow moulding process, the terahertz sensor is frequently placed on a level with the tooling outlet of the blow moulding machine where it records wall thickness sizes with a measuring frequency of 100 Hz. The large measuring range of 2.36” (60 mm) of QUANTUM BM often allows for the measurement of both wall thicknesses and the interior and exterior diameters of the melt flow.

HIGHLY FLEXIBLE FOR QUALITY CONTROL.

QUANTUM BM is suitable not only for inline operation but also for offline quality control. For the blow moulding process, robot-grippers frequently place the product before the static QUANTUM Terahertz sensor. Multiple points are inspected during this process.

INLINE WALL THICKNESS MEASUREMENT FOR CAST FILM!

IDEAL FOR CAST FILM.

QUANTUM Film features the proven QUANTUM Terahertz electronics, the Terahertz sensor with cable lengths of 10 m or 15 m and a traversing frame to measure the sheets. Frequently it is possible to measure not only the overall wall thickness size but to carry out a multiple layer measurement. Measuring accuracy is below ±10 µm.

Due to the non-ionising Terahertz radiation, QUANTUM Film is a perfect replacement for radioactive systems. Usually existing traversing units can remain in place for further use. Beside standard film types, QUANTUM Film can be used to measure also the wall thickness of paper, coatings, foam materials, fibreglass and insulations, all of them inline during the ongoing production process.

**TECHNICAL SPECIFICATION OF QUANTUM BM / QUANTUM FILM:**

**QUANTUM BM**

- Min. 100 Hz measurement of wall thickness and diameter of the melt flow
- Detailed product information
  - Wall thickness sizes (offline and on the melt flow)
  - Interior and exterior diameters (melt flow)
- Direct measurement independent of temperatures
- Maintenance-free
- Documentation of all measuring data

**QUANTUM Film**

- Sensor cable lengths for traversing optionally 32.8 ft or 49.2 ft
- Detailed product information
  - Wall thickness
  - Multilayer
- Direct measurement independent of temperatures
- Maintenance-free
- Documentation of all measuring data
- When combined with gravimetry:
  - Mass throughput control
  - Weight per length control via puller control or extruder
  - Thin points control

1 depending on material types and applicable measuring methods
The future-oriented and platform-independent concept allows visualization as a website by way of an easy integration via browser. As such, the iNOEX user interface is displayable on all web-enabled devices. The multi-touch surface allows an intuitive navigation through gestures (zooming, wiping).

Operation is carried out by way of installed widgets. On the interface, the user is free to configure, add or remove the widget’s size or information value, just as he wishes. As such, the user has constant access to his most important applications (favourites).

FAST CUSTOMER SUPPORT VIA TEAMVIEWER:

- Direct global support via remote control
- Easy configuration, no VPN gateways
- Adherence to the highest safety standards

ENORMOUS SAVINGS POTENTIAL.

QUANTUM systems offer not only an excellent price/performance ratio but also very short payback periods. Depending on mass throughput rates and production time, payback may even be within a few months.

### QUANTUM 360 (Ø 10” PE-PIPE)

<table>
<thead>
<tr>
<th>Throughput</th>
<th>Production time</th>
<th>Savings</th>
<th>Material costs</th>
<th>Savings p.a.</th>
</tr>
</thead>
<tbody>
<tr>
<td>1100 lb/h</td>
<td>16 hrs/day x 350 days/year</td>
<td>2.0% (THz)</td>
<td>0.70 $/lb</td>
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<tr>
<td>1100 lb/h</td>
<td>16 hrs/day x 350 days/year</td>
<td>3.0% (gravimetry)</td>
<td>0.70 $/lb</td>
<td>$129,360</td>
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<tr>
<td></td>
<td></td>
<td>5.0% total</td>
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<td>$215,600</td>
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### QUANTUM CP (Ø 24” PE-CORRUGATED PIPE)

<table>
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<tbody>
<tr>
<td>3000 lb/h</td>
<td>16 hrs/day x 350 days/year</td>
<td>2.0% (THz)</td>
<td>0.70 $/lb</td>
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<tr>
<td>3000 lb/h</td>
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<td>3.0% (gravimetry)</td>
<td>0.70 $/lb</td>
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<tr>
<td></td>
<td></td>
<td>5.0% total</td>
<td></td>
<td>$823,200</td>
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### QUANTUM FILM (LDPE-PIPE)

<table>
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<th>Savings</th>
<th>Material costs</th>
<th>Savings p.a.</th>
</tr>
</thead>
<tbody>
<tr>
<td>1300 lb/h</td>
<td>16 hrs/day x 350 days/year</td>
<td>2.0% (THz)</td>
<td>0.70 $/lb</td>
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<tr>
<td>1300 lb/h</td>
<td>16 hrs/day x 350 days/year</td>
<td>3.0% (gravimetry)</td>
<td>0.70 $/lb</td>
<td>$152,880</td>
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<tr>
<td></td>
<td></td>
<td>5.0% total</td>
<td></td>
<td>$254,800</td>
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