QUANTUM Terahertz systems

Terahertz wall thickness measurement in the plastics industry
For some years iNOEX GmbH has placed a special focus on the development and sale of Terahertz wall thickness measuring systems for the plastics industry and can justifiably term itself the pioneer of this key technology. iNOEX has since pursued this course and QUANTUM technology has been taken to the next level. This has become possible due to the special penetration properties of THz waves and the fact that T-rays are harmless to human beings. Probably the most popular example for non-destructive material testing by Terahertz is the quality inspection process of the plastic insulation used for the Space Shuttle by the American Space Agency NASA. 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.

MODULAR MEASUREMENT AND AUTOMATION FOR THE EXTRUSION PROCESS.

The production of plastic pipes is largely determined by the high demands on quality control, economic efficiency and productivity. 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. 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 an excellent price-performance ratio.

Allow me to introduce myself: I am a future designer.

“Together with my technology team I have developed and introduced to the market the first intuitively operated Terahertz system for wall thickness measurement in the pipe extrusion process. QUANTUM 360 stands for absolute measurement of almost any measuring task related to pipe layers or pipe wall thickness. It covers 360° of the pipe circumference.”

Ralph Klose, Director Technology iNOEX GmbH
QUANTUM - THE NEW DIMENSION OF WALL THICKNESS MONITORING

QUANTUM 360
The sensor of QUANTUM 360 revolves 360° around the pipe. It offers a high-precision wall thickness measurement from 25 µm (0.00098") to 60 mm¹ (2.36")¹. The automatic centering and the automatic focus setting allow a fully automated operation.

Absolute measurement of 360°¹

QuANtuum CP
QUANTUM CP is the first automation system for larger sized corrugated pipe extrusion lines. Wall thickness sizes and diameters of crown, valley, spigot and bell are measured reliably around 360°¹.

360° measurement of corrugated pipes!

QUANTUM TUBE
QUANTUM Tube is a static measuring system designed for measuring small tubes and hoses. Diameters range from 10 (0.39") to 32 (1.26") mm. The system offers a terahertz measurement of the total wall thickness on 4 points.

Highest precision for small tubes and hoses!

QUANTUM BM
QUANTUM BM - the first wall thickness and diameter measuring system for blow moulding. Inline measurement of wall thickness sizes and the diameter of the melt flow. Offline measurement of the wall thickness of 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 film extrusion. Inline measurement of the total thickness or multiple layers.

The perfect solution for film!

¹ depending on material types and applied measuring method
**STATE-OF-THE-ART TECHNOLOGY FOR A MAXIMUM MEASURING ACCURACY!**

Only a steady, continuous and overall stabilization of the extrusion process allows an efficient production process and thus ensures competitiveness in the plastics market. This requires a technology which is able to master the decisive functions „measurement & control“ and their perfect interaction and the related real 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\(^1\) (0.00098") to 60 mm\(^1\) (2.36") cover a wide spectrum of potential customer demands.

**ELECTROMAGNETIC SPECTRUM**

\(^1\) depending on material types and applied measuring method
ABSOLUTE MEASUREMENT OF 360°!

NEXT GENERATION.

QUANTUM 360 is a systematic further development. A special focus was set 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 a linear drive. 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. QUANTUM 360 sits on its own support fram and requires only minimum 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, an improved pipe centering, weight per length control and thin point control, material savings of up to 5% or more can be achieved.

BENEFITS:

• Detailed information on your product (wall thickness, diameters, eccentricity and ovalness)
• Absolute and COEX measurement
• Automatic centering, accuracy ≤ 50 mm (1.97”)
• Automatic focusing
• Functioning independent of pipe temperatures
• Electronic parts according to IP 65
• Material savings of 5% or more through:
  ▪ S-min or thin points control
  ▪ Improved centering
  ▪ Systematic start-up
  ▪ Weight per length control
  ▪ Simple operation
  ▪ Proven control principles

MEASUREMENT, CONTROL AND EVALUATION MODULES OF QUANTUM 360:

• Reversing wall thickness measurement of 360°
• Diameter measurement of up to 120 positions
• COEX measurement
• S-min control (without gravimetry)
• Alarm handling
• Documentation and iTREND
• When combined with gravimetry:
  ▪ Control of thin points
  ▪ Mass throughput control
  ▪ Weight per length control via haul-off or extruder
  ▪ Wall thickening
  ▪ Guide parameter control
  ▪ Bleeding function

<table>
<thead>
<tr>
<th>Type</th>
<th>Pipe dimension [mm]</th>
<th>Pipe dimension [inch]</th>
</tr>
</thead>
<tbody>
<tr>
<td>QUANTUM 360 / 250</td>
<td>32 - 250</td>
<td>1.26 - 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>
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 360° of the wall thickness and the 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 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.

360° MEASUREMENT OF CORRUGATED PIPES!

BENEFITS:
- Detailed information on your product (wall thickness, diameter)
- Direct measurement independent of pipe temperatures
- Material savings of 5% or more due to better centering, systematic start-up and weight per length control
- Optimum user support
- Documentation to submit 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 of 360°
- 360° wall thickness measurement, reversing
- Diameter measurement across up to 60 axes
- Alarm handling
- Documentation and iTREND
- When combined with gravimetry:
  - Mass throughput control
  - Weight per length control via extruder

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<th>Type</th>
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</tr>
</thead>
<tbody>
<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>
INLINE/OFFLINE MEASUREMENT FOR BLOW MOULDING!

UNIVERSALLY APPLIED.

QUANTUM is a universally applied system due to its high flexibility. Customized solutions for blow moulding, for both inline and offline measurement are already in service.

INLINE WALL THICKNESS MEASUREMENT POSSIBLE FOR THE FIRST TIME.

When used for inline operation in a blow moulding process, the terahertz sensor is frequently placed on the same level as the tooling outlet of the blow moulding unit where it records wall thickness sizes with a measuring frequency of 100 Hz. The large measuring range of 65 mm (2.56") 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!

PERFECT FOR CAST FILM.

QUANTUM Film features the proven QUANTUM terahertz electronics, the terahertz sensor with cable lengths of 10 m (32.80 ft) or 15 m (49.21 ft) 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 (0.0004")\(^1\).

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 the wall thickness of paper, coatings, foam materials, fibre glass 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 pipe temperatures
- Maintenance-free
- Documentation of all measuring data

QUANTUM Film
- Sensor cable lengths for traversing, optionally 10 m (32.80 ft) or 15 m (49.21 ft)
- Detailed product information
  - Wall thickness
  - Multilayer
- Direct measurement independent of pipe temperatures
- Maintenance-free
- Documentation of all measuring data
- When combined with gravimetry:
  - Mass throughput control
  - Weight per length control via haul-off or extruder
  - Thin points control

\(^1\) depending on material types and applied measuring method
MEASUREMENT, CONTROL AND EVALUATION BY QUANTUM TUBE:

- Total wall thickness
- Interior and exterior diameters across 2 axes
- Alarm handling
- Documentation and iTREND
- When combined with gravimetry:
  - Mass throughput control
  - Weight per length control via extruder
The iNOEX data manager (IDM) features a central data logger for the collection of all process and quality data of all standard iNOEX systems along the extrusion line. The software is installed on a virtual machine on an existing server in your network which means that no additional hardware is required. The analysis and evaluation of your data is carried out by the integrated iTREND function. Data can be downloaded for further processing, e.g. as CSV file.

**BENEFITS:**
- Access to all relevant product data
- Visualization and data evaluation by iTREND
- Older systems can be addressed by an additional gateway
- Supports quality assurance
- Easy access via web browser

iTREND visualizes your production and process values in the form of diagrams. Display of process data and time periods can be individually adapted by the user. Besides pre-defined diagrams the user-friendly software offers customized presentations of process values. Storage as CSV files permits the easy export of protocols for documentation purposes for the customer. Operation of iTREND is intuitive and it is done via web browser on PC, notebook or tablet in your network.

**FAST CUSTOMER SUPPORT VIA TEAMVIEWER:**
- Direct global support via remote control
- Easy configuration, no VPN gateways
- Adherence to the highest safety standards
### SUBSTANTIAL 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 250 mm PE-PIPE)

<table>
<thead>
<tr>
<th>Output</th>
<th>Production time</th>
<th>Savings</th>
<th>Material costs</th>
<th>Savings p.a.</th>
</tr>
</thead>
<tbody>
<tr>
<td>500 kg/h</td>
<td>16 hrs/day x 350 days/year</td>
<td>2.0 % (THz)</td>
<td>1.20 €/kg</td>
<td>67,200 €</td>
</tr>
<tr>
<td>500 kg/h</td>
<td>16 hrs/day x 350 days/year</td>
<td>3.0 % (Gravimetry)</td>
<td>1.20 €/kg</td>
<td>100,800 €</td>
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<tr>
<td></td>
<td></td>
<td>5.0 % total</td>
<td></td>
<td>168,000 €</td>
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#### QUANTUM 360 (Ø 1000 mm PE-PIPE)

<table>
<thead>
<tr>
<th>Output</th>
<th>Production time</th>
<th>Savings</th>
<th>Material costs</th>
<th>Savings p.a.</th>
</tr>
</thead>
<tbody>
<tr>
<td>1200 kg/h</td>
<td>16 hrs/day x 350 days/year</td>
<td>2.0 % (THz)</td>
<td>1.20 €/kg</td>
<td>161,280 €</td>
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<tr>
<td>1200 kg/h</td>
<td>16 hrs/day x 350 days/year</td>
<td>3.6 % (Gravimetry)</td>
<td>1.20 €/kg</td>
<td>241,920 €</td>
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<td>5.0 % total</td>
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<td>403,200 €</td>
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#### QUANTUM 360 (Ø 315 mm SN4 PVC-MULTILAYER PIPE)

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<tr>
<td>700 kg/h</td>
<td>16 hrs/day x 350 days/year</td>
<td>6.5 %</td>
<td>0.90 €/kg</td>
<td>229,320 €</td>
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* Special control algorithms using thermal centering combined with gravimetric weight per length control in compliance with rigidity SN4.

#### QUANTUM CP (Ø 800 mm PE-CORRUGATED PIPE)

<table>
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<tr>
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<th>Material costs</th>
<th>Savings p.a.</th>
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<tbody>
<tr>
<td>1400 kg/h</td>
<td>16 hrs/day x 350 days/year</td>
<td>2.0 % (THz)</td>
<td>1.20 €/kg</td>
<td>188,160 €</td>
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<td>1400 kg/h</td>
<td>16 hrs/day x 350 days/year</td>
<td>3.0 % (Gravimetry)</td>
<td>1.20 €/kg</td>
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<td></td>
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<td>5.0 % total</td>
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<td>470,400 €</td>
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#### QUANTUM FILM (LDPE-PIPE)

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<th>Material costs</th>
<th>Savings p.a.</th>
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<tbody>
<tr>
<td>600 kg/h</td>
<td>16 hrs/day x 350 days/year</td>
<td>2.0 % (THz)</td>
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<tr>
<td>600 kg/h</td>
<td>16 hrs/day x 350 days/year</td>
<td>3.0 % (Gravimetry)</td>
<td>1.20 €/kg</td>
<td>120,960 €</td>
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<tr>
<td></td>
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<td>5.0 % total</td>
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<td>201,600 €</td>
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#### QUANTUM TUBE (Ø 32 mm PE-PIPE)

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<th>Material costs</th>
<th>Savings p.a.</th>
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<tbody>
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<td>350 kg/h</td>
<td>16 hrs/day x 350 days/year</td>
<td>2.0 % (THz)</td>
<td>1.20 €/kg</td>
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<tr>
<td>350 kg/h</td>
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<td>3.0 % (Gravimetry)</td>
<td>1.20 €/kg</td>
<td>70,560 €</td>
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<td></td>
<td>5.0 % total</td>
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<td>117,600 €</td>
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