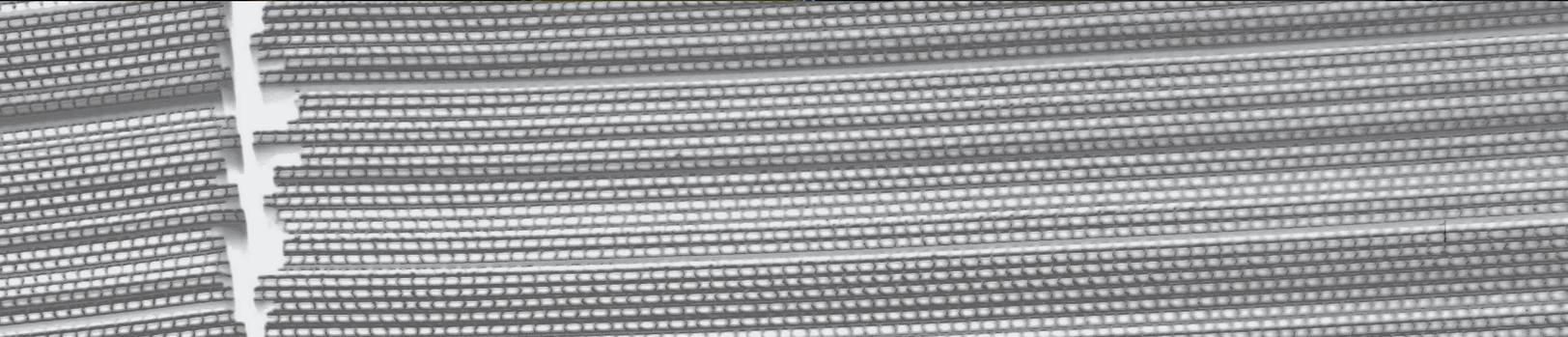




HAMMER-IMS

White
Paper

6 reasons to prefer M-Ray thickness & basis-weight quality control over nuclear and X-Ray systems



Enable higher quality and lower cost for production facilities of nonwovens, technical textiles, wall coverings, bitumen, rubbers, plastics and coatings



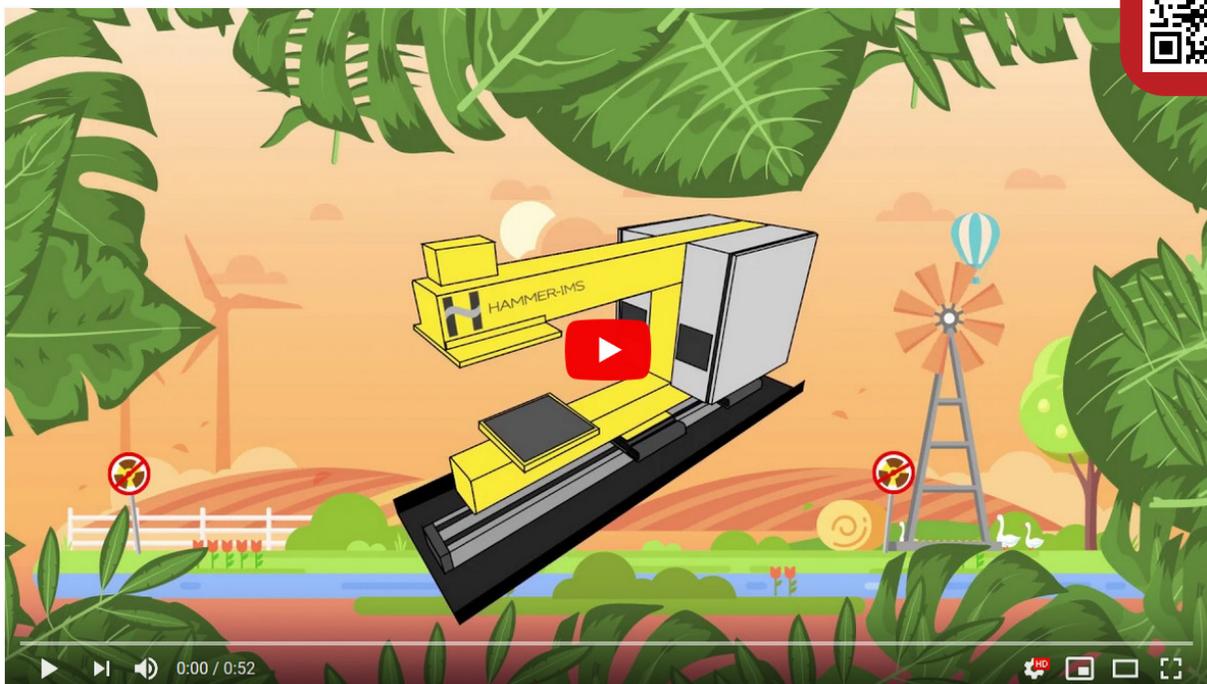
Hammer-IMS in Belgium commercializes contactless measurement solutions for thickness and basis-weight of flat materials in production lines as well as for detection of anomalies in these materials. Its disruptive M-Ray technology, based on the same type of waves that your cellphone emits, serves as an alternative for today's nuclear and radioactive measuring equipment. M-Ray based measuring machines running at manufacturers of technical textiles, wall coverings, bitumen, rubbers, plastics and coatings, are non-radioactive by design and deliver higher economic value and tighter quality control. This white paper digs deeper into the following six reasons to equip your organization with a Hammer-IMS machine:

1. Clean environment & high safety
2. High accuracy and superior material coverage
3. Flexibly employable across production lines & sites
4. High measurement gap
5. Wide application reach
6. Low Total Cost of Ownership (TCO)

While reading through the paper, references can be found to externally-available reading material under the form of internet links and QR-codes. This content can link to Hammer-IMS web pages, media publications or demo videos.

Let's dig into the first compelling reason...

bit.ly/explahammer



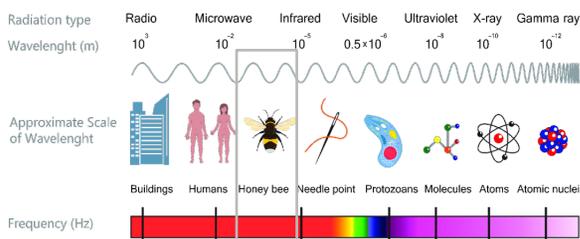
Reason 1

1. Clean environment & high safety

As introduced above, Hammer-IMS offers solutions for contactless measurement of thickness and basis-weight and for the detection of various anomalies in raw materials. Our disruptive so-called M-Ray technology combines millimeter waves (high-frequency electromagnetic waves) with innovative algorithms in order to create a viable alternative for nuclear and radioactive measuring equipment currently used in the market.

Millimeter waves have wavelengths of 1 to 10 mm, about the size of an insect (e.g. the honey bee as shown on the picture). We use millimeter waves as an enabler for precise and accurate measurements. Since millimeter waves have a lower frequency than visible light, they are non-ionizing and thus not harmful to humans and the environment in general.

Electromagnetic Spectrum



The wavelength of millimeter waves is about the size of an insect

Millimeter waves are also widely used as part of other commercial applications. On the picture you see millimeter wave antennas (white disks) for long-range communication between cell phone masts in the cellular network, an application named network backhaul connections. No rocket science, only advanced physics with innovative electronics, software and algorithms.



The M-Ray technology introduced by Hammer-IMS also has operational similarities with GPS. The GPS technology, which works with electromagnetic waves, offers approximately 20 meter altitude precision on a working distance of 20,000 km. Our M-Ray technology reaches comparable relative precision as it measures down to 1 micron over a working distance of 60 centimeters. Compare the ratios: 20 m/20 000 km roughly equals 1 micron / 60 cm and you will understand our comparison with the GPS system.



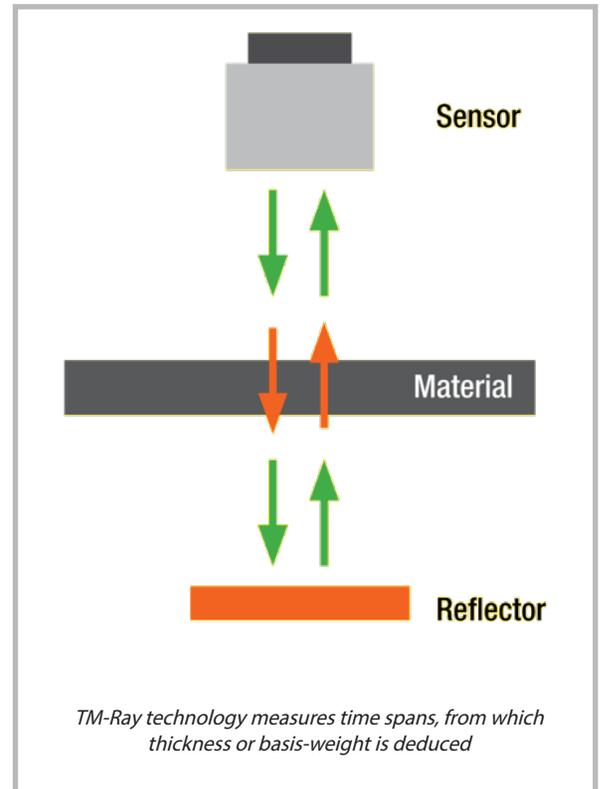
M-Ray technology has operational similarities with GPS



Millimeter wave antennas are part of network backhaul connections

In essence, the M-Ray technology is used to measure time spans. Our solutions measure how long it takes for the M-Rays to penetrate the material, bounce back on a reflector and return through the material back to the sensor/receiver head. Our specialists, which master time measurement engineering, reach precisions down to 1 gram per square meter (or 1 micrometer for thickness measurements).

Just like the GPS system or the cell phone backhaul system, the M-Ray technology does not involve any nuclear isotope, or any kind of ionizing waves. Let's now take a look at some concrete measurement capabilities...



A measuring system shows the measuring concept, which in this case, uses an M-Ray OEM module integrated into a C-frame machine

Reason 2

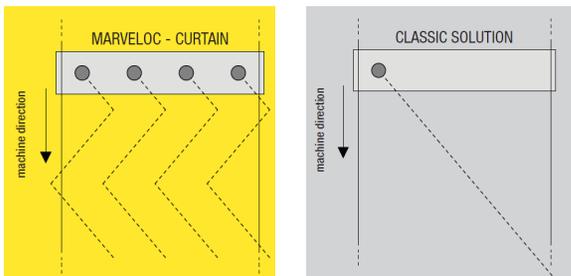
2. High accuracy and superior material coverage

The M-Ray machines have been developed to perform measurements 24/7 as part of an industrial production line.



Grandeco Wallfashion Group chooses Hammer-IMS for quality control of various wallfashion types

Multi-disciplinary engineering excellence enabled Hammer-IMS to realize economically-viable precision and robustness levels for its M-Ray millimeter wave technology. As mentioned, the systems are able to measure down to 1 gram per square meter (or 1 micrometer for thickness measurements). Hammer-IMS did not apply terahertz technology, as the current state of this technology is economically not viable.

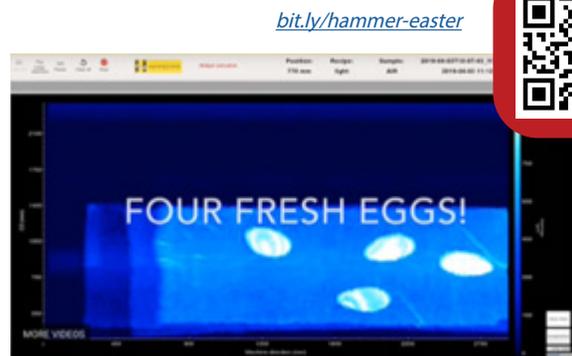


Operational difference between multi-head and single-head in terms of material coverage

Furthermore, the systems are typically equipped with multiple M-Ray sensors. With the machine frame traveling back and forth in transversal direction, maximum material coverage is obtained. The inline Hammer-IMS systems generate color graphs in real-time,

generated while doing the measurement job. This enables highlighting out-of-spec regions on the scanned material in terms of thickness or basis-weight by means of simple color highlights.

A playful example of maximum material coverage is the search of plastic 'Easter egg' shapes hidden in the scanned material.



M-Ray-based scanners are able to see through objects or measure thickness or weight of materials.

Hammer-IMS installs its M-Ray measurement technology basically in two types of frames: O-frames and C-frames. The C-frame solutions contains one or more sensors on a measurement arm up to two meters. The O-frame measurement systems deliver the frame robustness for accurate measurements across a wider span. In such a way, we support a wide range of production line widths.

Reason 3

3. Flexibly employable across production lines & sites

The flexibility of Hammer-IMS solutions is built into the system software. The Human-Machine interface (HMI for insiders) of all C-frame and O-frame measuring solutions is embodied by the Hammer-IMS Connectivity software.



bit.ly/hammer-silac



SILAC uses a clean Marveloc-CURTAIN for inline basis-weight quality control of felts & nonwovens - Technical Textiles magazine

The Connectivity software controls any measurement solution in a single software environment, regardless whether using a single-sensor or a multi-sensor system. For any activated application, software settings are specified and tuned to meet the measurement requirements of individual customers. The software also supports communication standards such as Profinet, OpenSSH, FTP, Modbus and EtherCAT, which can form the core of a feedback system to automatically adapt line parameters, e.g. knife-coating case.

Our software is also available for bolt-feedback projects in plastic extrusion.

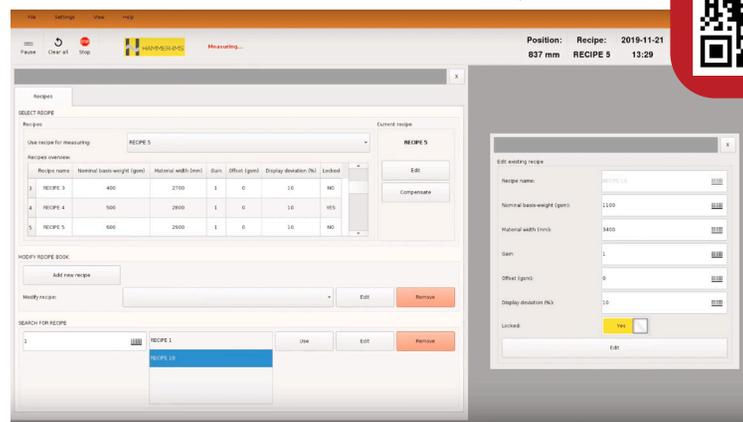
The Connectivity software is easy to use, contains various industry-specific visualizations, and is available pre-installed on a rugged industrial PC or a desktop PC offering a widescreen experience. The software offers a various number of both time-stamped and position-based visualizations.



The Connectivity 3.0 software continuously displays quality control results

Most of the scanner systems run as part of in-line production lines of nonwovens, technical textiles, wall coverings, bitumen, rubbers, plastics and coatings. The Hammer-IMS software supports closed-loop feedback control. It allows the production to be adjusted automatically to maintain high production quality and minimize material scrap.

bit.ly/hammersoft



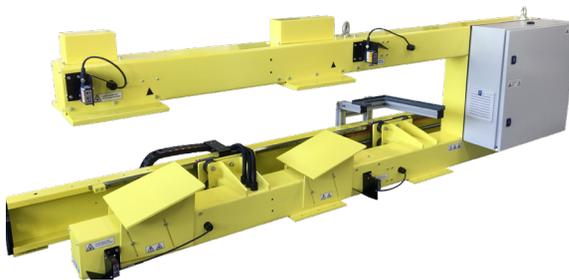
Discover the Hammer-IMS Connectivity 3.0 software capabilities in this video coverage

C-frame systems can serve as a fixed quality control (QC) station in a single production line, and can be moved flexibly to other lines. At the same time, these solutions are particularly useful for lab applications.

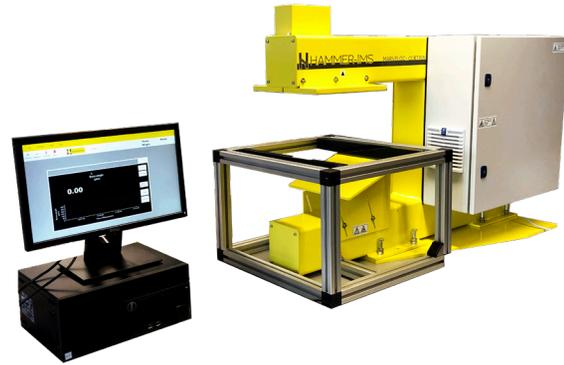


A C-frame machine can be flexibly used in production lines and for lab use

The terminology of 'Flexibility' also includes adapting geometrical constraints of measuring machines where needed. The picture illustrates a linear drive on the side to reduce machine height. The Hammer-IMS engineering team is ready to discuss optional machine adaptations to meet specific customer requirements.



Picture illustrating linear drive on the side to reduce machine height



A flexible, compact and affordable lab system configuration

Lab system configurations are available with feeders and desktop computers, with a fixed or scanning sensor. These provide thorough insights into material properties and geometries as part of developing new materials or production techniques.

The M-Ray based solutions, which are non-nuclear and non-radioactive in nature, can serve as a moveable quality control solution. The systems on wheels can be readily used in different production lines or laboratories, even in different sites. For this purpose, The M-Ray technology of M-Ray measuring systems does not require any licensing. The flexible use of a single system in different locations divides the purchase cost of the system over multiple produced goods.

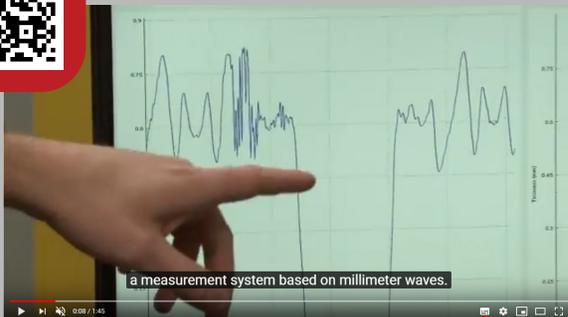
Side Note

Belgian non-nuclear measuring innovation

Hammer-IMS is a high-tech industrial sensing company based in Hasselt, Belgium. Its disruptive M-Ray technology combines millimeter waves (high-frequency electromagnetic waves) with innovative algorithms in order to create a powerful alternative for today's nuclear and radioactive measuring equipment.



bit.ly/Introhammer



Hammer-IMS as news item on Belgian business TV channel

The Hammer-IMS solutions perform contactless measurement of thickness and basis-weight as well as anomalies of flat structures in production lines. The modular and robust systems offer up to micron level accuracy in laboratories and in industrial in-line production lines and lab environments.

The solutions of Hammer-IMS are running at international manufacturers of nonwovens, technical textiles, wall coverings, bitumen, rubbers, plastics and coatings. The M-Ray based solutions are favorable in situations where conventional technologies such as optical technologies, nuclear or radioactive radiation, ultrasound waves, inductive or capacitive measurement systems, etc. fail, are undesirable or provide an unreliable output.

Sensor Fusion

Hammer-IMS measuring systems can integrate a range of third-party sensors to make the scanners even more intelligent. Hammer-IMS can integrate:

- Eddy Current sensors, for measuring the distance from the M-Ray sensor to a metal base plate mounted underneath the material to be measured
- Laser time of flight (TOF) or triangulation sensors, for hybrid thickness measurement or detection purposes
- Laser curtain sensors, for surface roughness measurement
- Laser indicators to mark where the M-Ray measurement is taking place (see video)
- Laser sensors for thickness measurement on basis-weight measuring solutions (see picture)
- Laser sensors for edge detection
- Moisture sensor for jointly measuring of basis-weight and moisture content in wet-laid nonwoven processes
- Air permeability sensor for jointly measuring performances of nonwoven filtration media and basis-weight
- Stack lights for visualization of alerts



Laser sensors and other sensors can be integrated into M-Ray based systems for various reasons

Miniaturization

Flexibility is essential for Hammer-IMS. Its continuous drive toward higher measuring performance packaged in a smaller form factor opens up new markets and applications. By packaging the M-Ray measurement technology in an OEM module enables machine manufacturers to flexibly integrate the technology into their quality control equipment.



Miniaturization within Hammer-IMS

OEM module

The new OEM module of Hammer-IMS exists thanks to Gordon Moore, the founder of Intel. Moore's Law states that the speed and capability of electronic chips double every couple of years which results in electronic circuitry becoming smaller in size and more affordable.

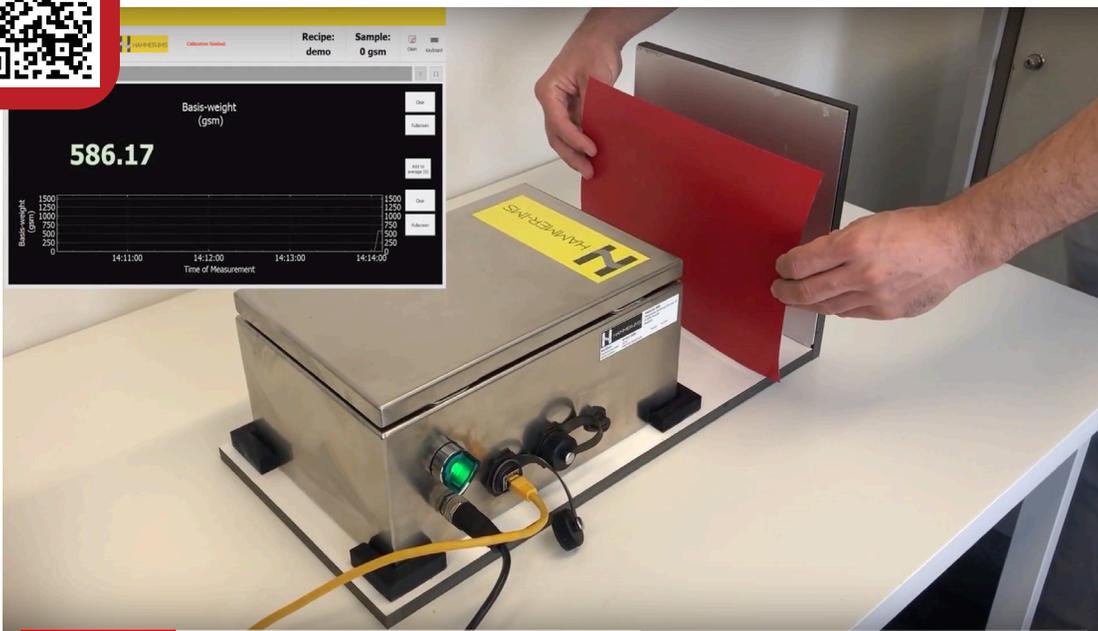


OEM solution

The miniaturization and democratization enables Hammer-IMS to come with an affordable OEM solution with a compact form factor. The smaller in size, the easier and more flexible it becomes to integrate measuring and processing units.



bit.ly/hammerOEM



The M-Ray OEM module allows machine manufacturers to flexibly integrate M-Ray technology into their QC equipment

When we extrapolate Moore's law, the future could hold the opportunity to simply hook up a number of cell phone sized modules on a steel beam to run inline quality control. The picture below is a mock-up which clearly illustrates the vision of Hammer-IMS.



The Belgian Trends magazine featured our visionary quality control insights toward 2025 and some innovative consumer applications arising from these.



bit.ly/hammerknack



Trends

HAMMER-IMS

Meten met radartechnologie

Radartechnologie is een slim alternatief voor de nucleaire en radioactieve meetsystemen in productielijnen. De Limburgse start-up Hammer-IMS ziet daarnaast ook tal van consumententoepassingen. Roel Van Espen

Meten met radartechnologie - Trends magazine (Belgium - Dutch language)

Reason 4

4. High measurement gap

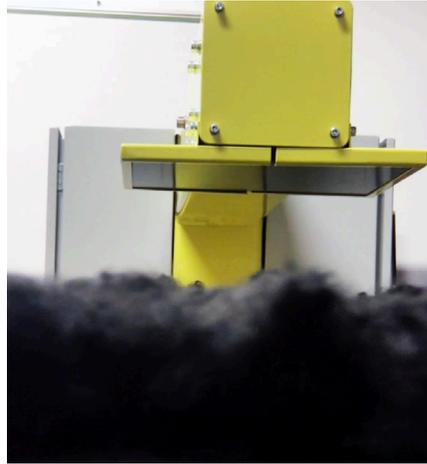
The high standoff distance of M-Ray based systems is revolutionary. It allows for verifying thick nonwovens just as easily as thin plastic sheets.

The high clearance distance up to 30-40 centimeters compares favorably to conventional measurement technologies where sensors are typically operating with a standoff distance of only 1 centimeter! The high clearance distance means also that the metal M-Ray reflector plate under the inspected material is positioned at a considerable distance. The use of a metal reflector plate eliminates any electronics below the production line. The advantage is that important parts of the machine cannot be contaminated irreversibly by coating or bitumen drips or a drooping extruded sheet, for example.



Most Hammer-IMS machines offer a standoff distance of approximately 30 cm, offering distinct advantages

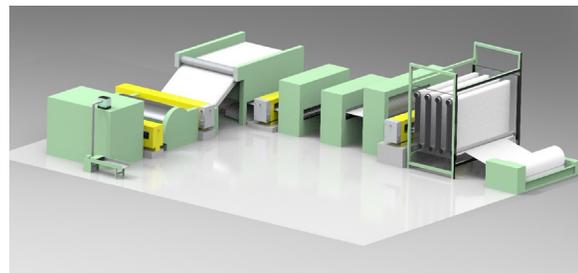
The high clearance distance offers a number of additional advantages. Obviously, it avoids markings caused by sensor parts touching the material even when the customer's production line faces high levels of flutter. Furthermore, Hammer-IMS measuring systems do not have to be removed from the production line by an operator while routing the material through the production machine. Thus, the high standoff distance reduces operator interaction and



The high measuring gap allows for efficient and flexible quality control of thick materials

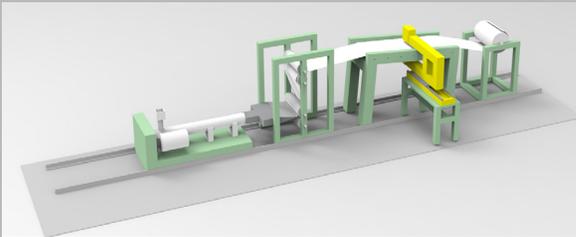
avoids uninspected production batches when the operator forgets to reinsert the scanner into the line.

The high measurement gap is beneficial for evaluating thicker nonwoven materials in the earliest process stages, i.e. straight after the feeder or carding stage. As such, the Hammer-IMS systems can be used at all stages in the nonwovens production process, unlike existing systems on the market.



Nonwoven line

In plastic extrusion lines, the high clearance distance allows Hammer-IMS measuring systems to be positioned right after the chilling rolls. There, the system is able to robustly measure the hot, freshly extruded material without touching it. The substantial clearance ensures that the M-Ray sensor does not get overheated.



Plastic extrusion line

Overall, the high measurement gap ensures that the measurement systems do not get damaged easily and that the systems can operate in all production stages. So, high maintainability and employability are guaranteed under all circumstances.

Reason 5

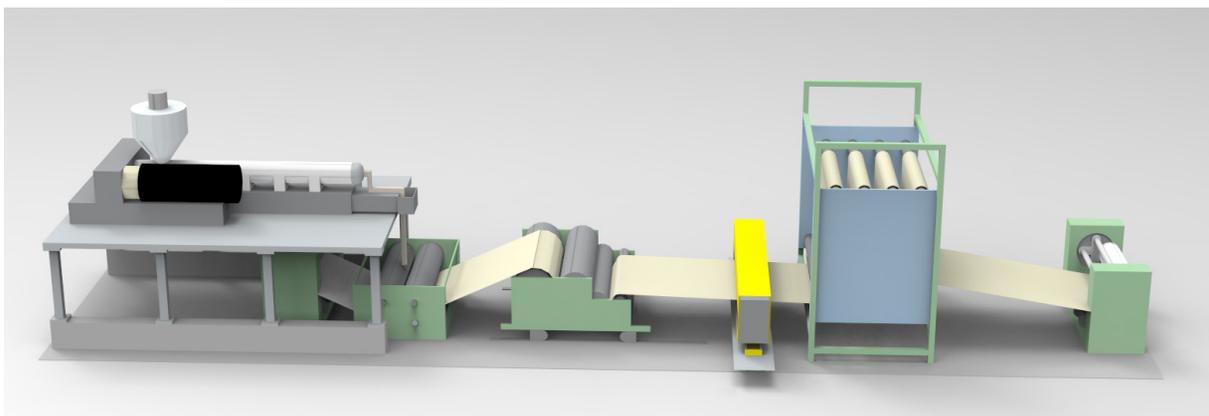
5. Wide application reach

The M-Ray technology of Hammer-IMS is suitable for a long list of non-metallic materials across a range of industries. Contact Hammer-IMS to have your material verified by our specialists by sending us some samples.

Technical textiles are available in different types, including wovens and nonwovens as well as knit and braid materials. The basis-weight of these materials can be verified using M-Ray based measurement systems of Hammer-IMS.

The measurement solutions of Hammer-IMS also support basis-weight verification of **laminated textiles**.

- **Drylaid nonwovens**, regardless whether webformed using thermal bonded, needle-punched, spunlaced and chemically bonded, can be measured using Hammer-IMS systems. The high clearance distance of the measuring solutions is beneficial for evaluating thicker nonwoven materials in early process stages.
- **Coatings**, both calendaring and knife coating processes, are applied in the production of truck tarps, tents, and wall coverings. Using PI-controlled process feedback, the customer provides the motors and the motor drivers to allow Hammer-IMS to directly control the height and the tilting of the calendars or the coating knives.



Calendar coating line

Plastic sheets exist in a range of materials: low-density polyethylene (LDPE), high-density polyethylene (HDPE), polypropylene, polystyrene, and polyvinyl chloride (PVC), polycarbonate (PC), acrylic glass, etc. Hammer-IMS quality control solutions are suited to measure the thickness of any extruded plastic material:

- Plastic extruded sheet
- Plastic cast film and sheet
- Extruded foam

bit.ly/hammer-orfit



Belgian medical devices supplier Orfit Industries opted for non-nuclear Hammer-IMS thickness measurement system - EPPM magazine

Hammer-IMS accepts projects requiring a closed-loop die controller, which keeps the thickness of the material being extruded steady. The control maps positions in cross-machine direction to the corresponding bolt of the extrusion die. Neck-in is an important phenomenon to make sure that the mapping is adequately performed. Furthermore, we provide power electronics components to drive the thermobolts directly.

Other markets where Hammer-IMS is gaining momentum include bitumen, rubber sheets and wall coverings. In the market of vinyl-based wall coverings, for example, the process of manufacturing paper or fabric based wall coverings entails coating, printing and pre-pasting. Before curing, the basis-weight of finished wall coverings can be verified using Hammer-IMS basis-weight quality control.

Similarly, flat rubber sheets, used for mechanical damping and acoustic applications can undergo dimensional quality control using a Hammer-IMS thickness measuring system. Bitumen is widely used in the construction of asphalt roads and bituminous membrane products. Hammer-IMS measurement solutions are suitable for basis-weight quality control of flat bitumen material.

Reason 6

6. Low Total Cost of Ownership (TCO)

The flexibility and versatility of Hammer-IMS solutions reduce the total cost of ownership (TCO) of inline measurements significantly. That is why an increasing number of manufacturers opt for M-Ray based quality control systems. Here are the three reasons why.

Firstly, the measurement solutions of Hammer-IMS are able to measure both thick and thin materials, or heavy and light materials if you like. This means that a single device can have multiple purposes throughout its lifetime in a single plant.

Secondly, the flexibility to move a measurement system across multiple production lines without any need for re-initiating the application procedure for a radioactive license, further optimizes TCO levels.

Thirdly, Hammer-IMS does not force you to get involved into risk assessment procedures and safety precautions related to radioactivity. Furthermore, government-controlled inspections, nuclear waste management or expensive nuclear source replacements are not applicable. We have a quantified case where a Hammer-IMS measurement solution is introduced in replacement of traditional nuclear or radioactive system. When considering the investment cost and all expenses associated throughout the lifecycle, the equation is clearly in favor of the M-Ray based solutions of Hammer-IMS.

Below you find a case, financially quantified over a period of twenty years. Note that in the calculations we are only taking into account the effect of the clean nature (non-radioactive) of the system:

1. An M-Ray based measuring solutions of Hammer-IMS lasts its entire lifetime without requiring any source replacements whatsoever. Such an ecologic solution compares favorably with the limited lifetime of isotope material (e.g. Kr-85: lifetime of 10.7 years) or an X-Ray tube (approx. 5-15 years). Each material or tube replacement/recycling costs approx. 10,000-20,000 euros.
2. Nuclear or radioactive measuring systems imply a range of additional expenses, including:
 - Nuclear safety inspection
 - Contributions to regulatory institutions, both initially and periodically
 - Operator safety training and prevention and monitoring

The financial impact of the latter aspect on the total cost of ownership of a single scanner over a lifetime of 20 years is between 40,000 up to -100,000 euros.



Conclusion

Clean M-Ray quality control solutions: a smart choice!

It is a smart choice of manufacturers to opt for non-nuclear and non-radioactive quality control solutions of Hammer-IMS. The eco-friendly measurement machines for thickness, basis-weight and anomaly detection ensure a healthier and greener environment - as encouraged by governments.

bit.ly/hammer-auto



Tier 1 supplier Autoneum selected non-nuclear Hammer-IMS Marveloc-CURTAIN system for R&T Center in Switzerland

Gain time, save material and increase product quality with Hammer-IMS M-Ray machines, which are purely electronic by design. Flexibly and securely measure a broad range of materials - including coatings and laminations - across all production process stages, thanks to the high machine clearance.

The scanners of Hammer-IMS manage multiple sensors and the integrated software environment dynamically displays measurement data in high definition. Furthermore, it supports seamless interaction with production platforms over conventional field bus links. Overall, the Hammer-IMS solutions offer accurate (inline) measurement accuracies and reduce the total cost of ownership drastically over their entire lifecycle.



Hammer-IMS nv

Kempische Steenweg 293, bus 36, 3500 Hasselt, Belgium.

www.hammer-ims.com

info@hammer-ims.com

VAT (BE) 0648.896.643 RPR Antwerpen, department Hasselt

The data as listed above is non-binding. Contact us to obtain a dedicated technical datasheet, a feasibility analysis for your industrial case, or to get in touch with our preferred integrators.

© Hammer-IMS nv 2020. Our general terms and conditions apply.