WELCOME TO FOM TECHNOLOGIES

FOM Technologies is a leading supplier of lab- and pilot-scale slot-die coating tools for thin film materials research. We provide precise, flexible, user-friendly equipment to the world’s finest companies and universities to advance the state of energy, medical and other diverse smart surface technologies. Our “MO” is to work closely with our clients and suppliers to deliver high quality, cutting edge solutions to coat a bright and sustainable future together.

FOM Technologies is a publicly traded company. The company was listed on the Nasdaq First North Growth Market in June 2020 (ticker: FOM).
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THE BASICS

How it works

Slot-die coating works by dissolving a desired thin film material into a coatable solution. This solution is pumped into the slot-die head component, where it becomes uniformly spread along the desired coating width. This results in controlled, continuous thin film production at the slot-die outlet, where the solution is received by a moving substrate. Because all of the solution that exits the slot-die ends up on the substrate, an optimized slot-die coating process affords nearly 100% material efficiency and allows us to pre-determine the film thickness simply by controlling the pump rate and substrate speed.

Our benefits in thin film R&D

- Uniform film thicknesses from 10 nm to 100 μm
- Quick to start & easy to use
- Simple, predictable film thickness control
- Easily scaled from a few cm² to tens of m² per minute
- Compatible with almost any material and viscosity
- Continuous, non-contact thin film coating process
- Closed system protects your materials
- More precise, efficient and scalable than spin coating, blade coating, screen printing & inkjet printing
- Compatible with R2R and S2S production methods
- Demonstrates upscaling and commercial potential for new processes
- Can downscale large processes for rapid iteration
A flexible tool for research and production

Slot-die technology enables straightforward coating of thick- and thin films from almost any material. The technique offers flexible compatibility with diverse solution viscosities, solids concentrations, and final thicknesses ranging easily from just 10 nm up to several hundreds of microns. FOM Technologies slot-die tools put these capabilities into your hands at the push of a button.

Beyond flexibility towards materials and thicknesses, slot-die coating offers unparalleled scalability between small and large areas, enabling rapid cycling between research and production scale workflows. Through simple hardware adjustments, FOM Technologies slot-die tools allow for hassle-free sample production ranging from just a few mm² to several m² per minute without sacrificing quality or usability.
Precise. Predictable. Scalable.

FOM Technologies brings industrial Slot-Die solutions to the R&D environment. Our tools simulate high-throughput, large-area coating processes in a convenient footprint. This enables our clients to couple fundamental R&D with commercial material and process optimization, without compromising quality or convenience in either respect. Compared to conventional lab-scale techniques, Slot-Die coating offers simply unmatched control, flexibility and scalability of thin film research.

<table>
<thead>
<tr>
<th>PARAMETER</th>
<th>SPIN COATING</th>
<th>BLADE COATING</th>
<th>INKJET PRINTING</th>
<th>SLOT-DIE COATING</th>
</tr>
</thead>
<tbody>
<tr>
<td>Thickness range</td>
<td>~ 10 nm - 100 μm</td>
<td>~ 1 - 100 μm</td>
<td>10 - 300 nm</td>
<td>~ 10 nm - 500 μm</td>
</tr>
<tr>
<td>Coating speed (m/min)</td>
<td>-</td>
<td>0.1 - 1,500</td>
<td>&lt; 1</td>
<td>0.1 - 500</td>
</tr>
<tr>
<td>Max. coating area (cm²)</td>
<td>10 x 10 (typically &lt;&lt; 25 cm²)</td>
<td>400 x L</td>
<td>-</td>
<td>400 x L</td>
</tr>
<tr>
<td>Viscosity range (cP)</td>
<td>&lt; 1,000</td>
<td>100 - 40,000</td>
<td>5 - 20</td>
<td>&lt; 20,000*</td>
</tr>
<tr>
<td>Layer uniformity (%)</td>
<td>&lt; 5</td>
<td>&lt; 10</td>
<td>&lt; 5</td>
<td>&lt; 5</td>
</tr>
<tr>
<td>Web roughness effect</td>
<td>-</td>
<td>Large</td>
<td>Small</td>
<td>Small</td>
</tr>
<tr>
<td>Throughput method</td>
<td>Batch</td>
<td>Continuous</td>
<td>Continuous, intermittent and batch possible</td>
<td>Continuous, intermittent and batch possible</td>
</tr>
<tr>
<td>Delivery method</td>
<td>Volumetric, pre-metered</td>
<td>Mechanical, self-metered</td>
<td>Volumetric, pre-metered</td>
<td>Volumetric, pre-metered</td>
</tr>
<tr>
<td>Material waste</td>
<td>Very high</td>
<td>Moderate</td>
<td>Low</td>
<td>Very low</td>
</tr>
<tr>
<td>Thickness Predictability</td>
<td>Moderate</td>
<td>Moderate</td>
<td>Moderate</td>
<td>High</td>
</tr>
</tbody>
</table>

*Viscosity range depends on whether the application requires solution processed Slot-Die Coating versus melt based extrusion coating. Extrusion is achievable in a Slot-Die apparatus and functions with much higher viscosities.

Best performance
A predictable coating process

The wet film thickness in slot-die coating depends purely on the liquid pump rate and coating speed, not the height of the slot-die itself! Slot-die coating can be considered as highly precise painting of a thin material film, rather than scraping or flinging as seen in other techniques.

\[ t_{\text{wet}} = \frac{Q}{U \cdot w} \]

Ink concentration then gives the final dry thickness upon removal of the solvent.

\[ t_{\text{dry}} = t_{\text{wet}} \cdot \frac{c}{\rho} \]

Through this “pre-metered” mechanism, slot-die coating affords contact-free coating uniform, scalable thin films with high repeatability and little risk of scratching or damaging samples in the process of coating.
FILM QUALITY CONTROL

Controlling the finer details

As with all solution-based coating techniques, optimizing the quality of a slot-die coated film depends on a variety of key process parameters, including:

• The process pump rate ($Q$) and coating speed ($U$)
• The ratio of slot-die height versus wet film thickness
• Material composition (viscosity and surface tension)
• Pressure gradients across the meniscus
• Wetting and surface energy between ink and substrate
• Downstream drying conditions
• Flow properties of the slot-die component
• Motion uniformity and isolation from vibrations

FOM Technologies slot-die coating tools are designed to provide simple control of these important variables. Through our research-focused design philosophy and user-friendly control interface, we enable you to get started quickly with the science of thin film development, spending more time on your research and wasting less time on mundane setup and hardware troubleshooting.
SIMPLE PROCESS SCALING

From lab to fab and back again

The excellent scalability of slot-die based processes arises from several key properties, including:

- Simple cycling between large and small areas via easy hardware adjustment for wider or narrower coatings
- Convenient scaling to higher throughput by simple adjustments to pump rate and coating speed
- Excellent yields and low cost/waste thanks to high material efficiency (ca. 99%)
- Direct transferability of lab-scale processes to industrial production thanks to convenient roll-to-roll (R2R) and sheet-to-sheet (S2S) compatibility

FOM Technologies slot-die tools are designed to provide a low barrier to entry for these scaling advantages, enabling development, proof-of-concept testing, and rapid iteration of R2R and S2S compatible process without the cost or hassle of operating conventional commercial/pilot scale slot-die equipment. Our tools are designed to fit perfectly into your development workflow so you can have full confidence in your process before investing in a full-scale slot-die production solution.
DISCOVER SLOT-DIE COATING

Industrial history

Slot-die coating is a proven technology for the precise, scalable production of thick and thin films of almost any material. It was originally invented in the 1950’s and is widely used in commercial roll-to-roll manufacturing of photographic films, Li-ion batteries, ceramic capacitors and many other products.

R&D applications

Many of tomorrow’s most exciting inventions, such as printed solar cells, solid-state batteries and lab-on-a-chip medical diagnostics, rely on large scale deposition of high quality thin films and coatings to reach their full potential.

However, today’s conventional lab-scale coating techniques cannot deliver the required combination of precision and scalability to R&D professionals. Slot-die coating meets these needs, and FOM Technologies is making this technology available in a lab-scale form factor for the first time.
THIN FILM R&D BENEFITS

Thin film solar
- R2R compatibility and simple up/downscaling
- Thin films down to 10 nm for active layers, ETL, HTL, passivating layers and anti-reflective coatings
- Easy integration of nitrogen blade for fast drying and perovskite quenching
- High material efficiency saves expensive polymer cost and waste

Batteries
- Boosts viability of new battery technologies by developing on current Li-ion standard manufacturing platform
- Highly flexible target thicknesses (10 nm – 100 μm) and viscosities (1-20,000++ cP) for diverse battery coatings (thick electrodes, thin solid electrolytes, interlayers and protective coatings)
- Closed system protects sensitive materials before coating

PEM fuel cells
- PEM fuel cells
- R2R compatibility and simple up/downscaling
- Highly flexible target thicknesses (10 nm – 100 μm) and viscosities (1-20,000++ cP) for diverse fuel cell coatings (electrolytes, catalysts and microporous layers)
- High material efficiency saves expensive catalyst cost and waste

Medical
- R2R compatibility and simple up/downscaling
- Highly flexible target thicknesses (10 nm – 100 μm) and viscosities (1-20,000++ cP) for e.g. concentrated drug films, novel medical imaging materials, hydrophobic/hydrophilic interface coatings and selective membrane layers in printed drug sensors and diagnostic devices
- Closed system protects materials and prevents contamination