

AIR BEARINGS: THE FUTURE OF SEMICONDUCTOR MANUFACTURING

5 AIR BEARING APPLICATIONS

FOR THE NEXT GENERATION OF SEMICONDUCTOR MANUFACTURING

Author: New Way Air Bearings

Introduction

The semiconductor industry underpins our modern lifestyle, producing chips for everything from consumer electronics and toys to vital military hardware and integrated systems for modern electric vehicles. Manufacturing semiconductors and chips is a complicated process, involving many detailed, precise steps. These include:

**Vapor Deposition and Etching | Lapping and Grinding |
Wafer Inspection | Pick and Place Systems | Photolithography**

Whether your business is producing semiconductors as an OEM or you operate further down the supply chain, semiconductor manufacturing is among the most rigorous of modern processes, requiring a unique and stringent combination of:

**Precision Motion | Cleanroom Compliance | High Speed Operation
Crash Resistance | Long Term Durability**

New Way Air Bearings[®] is familiar with tackling new technologies and advancing them by leaps and bounds. Our first product line of linear air bearings was designed to enhance the precision of coordinate measuring machines (CMM)'s. Air bearings offer unparalleled straightness, speed, durability, and cleanroom compatibility across both linear and rotary motion applications.

Our air bearing systems can be designed and integrated for entirely new processes, or readily retrofit into your existing infrastructure. With more than 25 years of experience in turnkey engineering, New Way is ready to bring the benefits of porous carbon air bearings to semiconductor manufacturing.

In this eBook, you'll learn how New Way Air Bearings—powered by our proprietary Porous Media Technology™—offer unique solutions for the exacting standards demanded by the semiconductor manufacturing sector. By the end, you'll see just how much potential Frictionless Motion™ provides you, no matter where in the semiconductor supply chain you are.

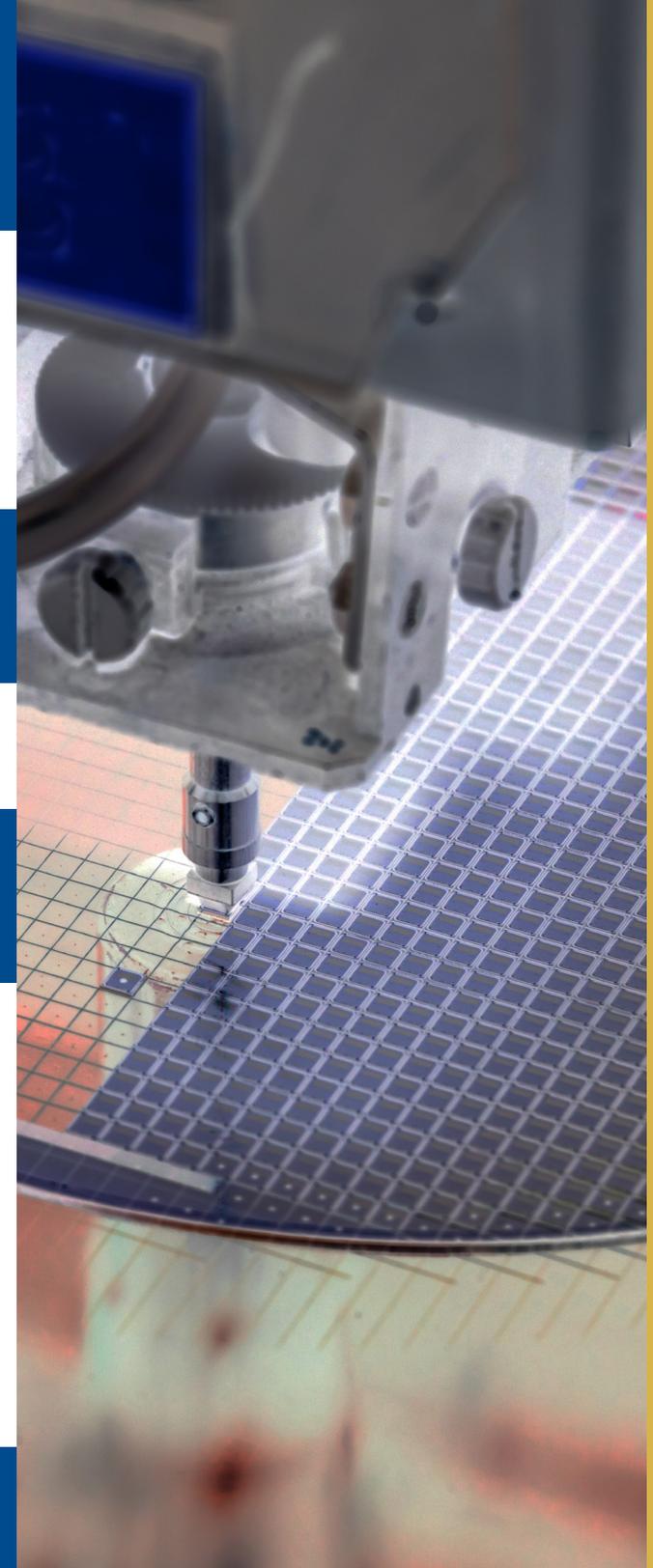
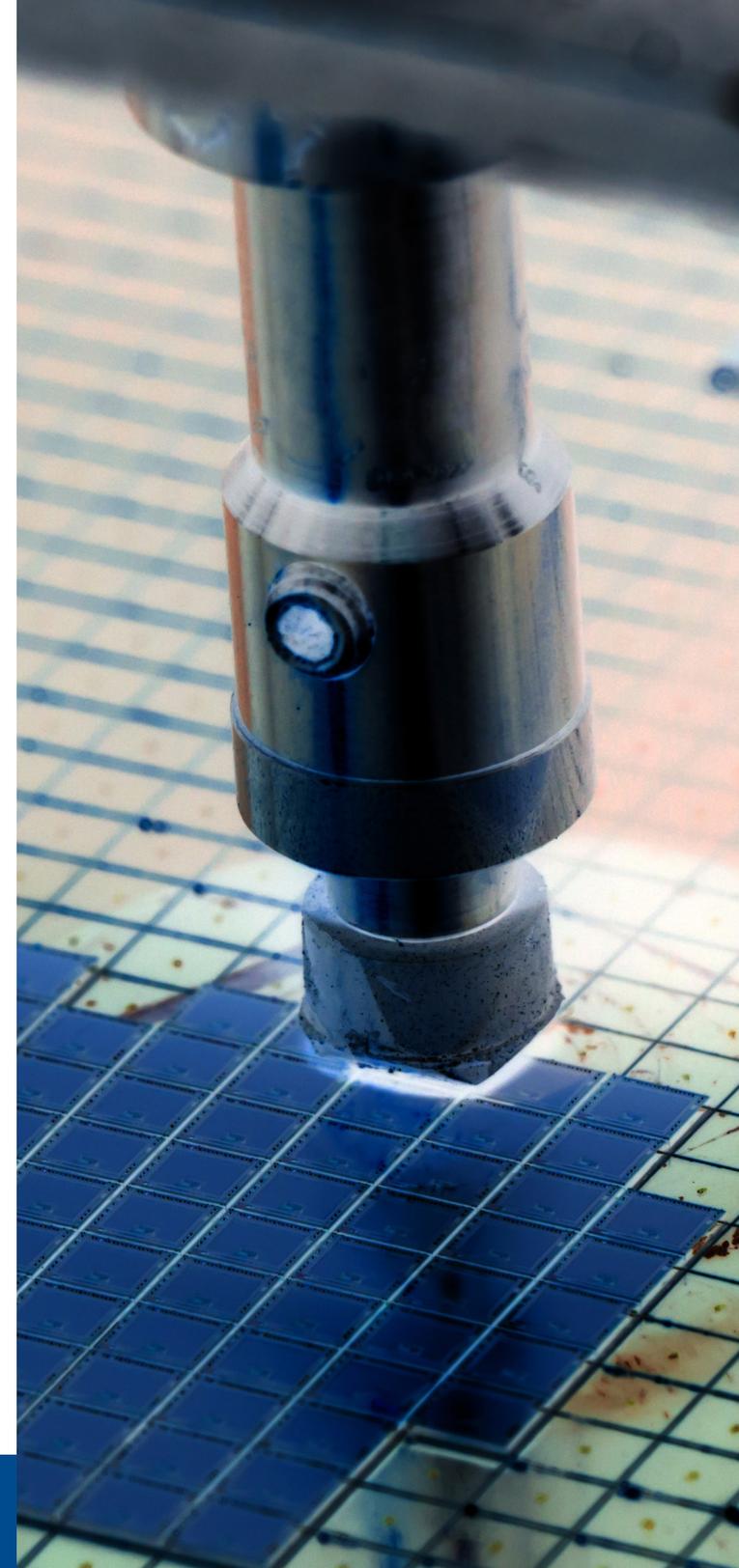
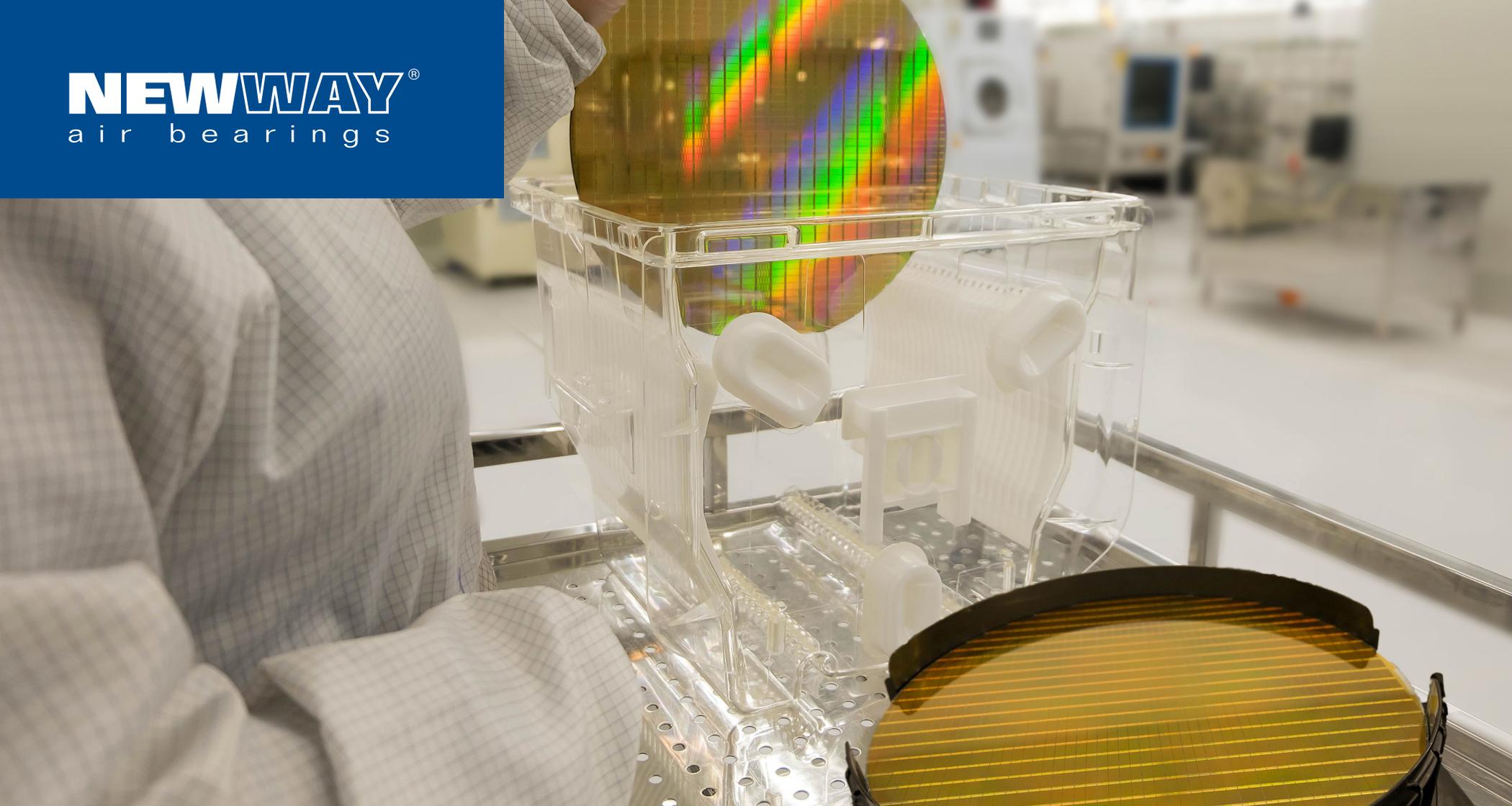


TABLE OF CONTENTS

1. Introduction	2
2. Vapor Deposition and Etching	4
The Challenge	5
How Porous Media Air Bearings Deliver	5
3. Lapping and Grinding	6
The Challenge	7
How Porous Media Air Bearings Deliver.....	7
4. Wafer Inspection	8
The Challenge	9
How Porous Media Air Bearings Deliver.....	9
5. Pick and Place	10
The Challenge	11
How Porous Media Air Bearings Deliver.....	11
6. Photolithography	12
The Challenge	13
How Porous Media Air Bearings Deliver	13
7. Reimagining Semiconductor Manufacturing	14
8. About Drew Devitt	15
9. About New Way Air Bearings	15



NEWWAY[®]
air bearings



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**Vapor Deposition
and Etching**

Vapor Deposition and Etching

The Challenge

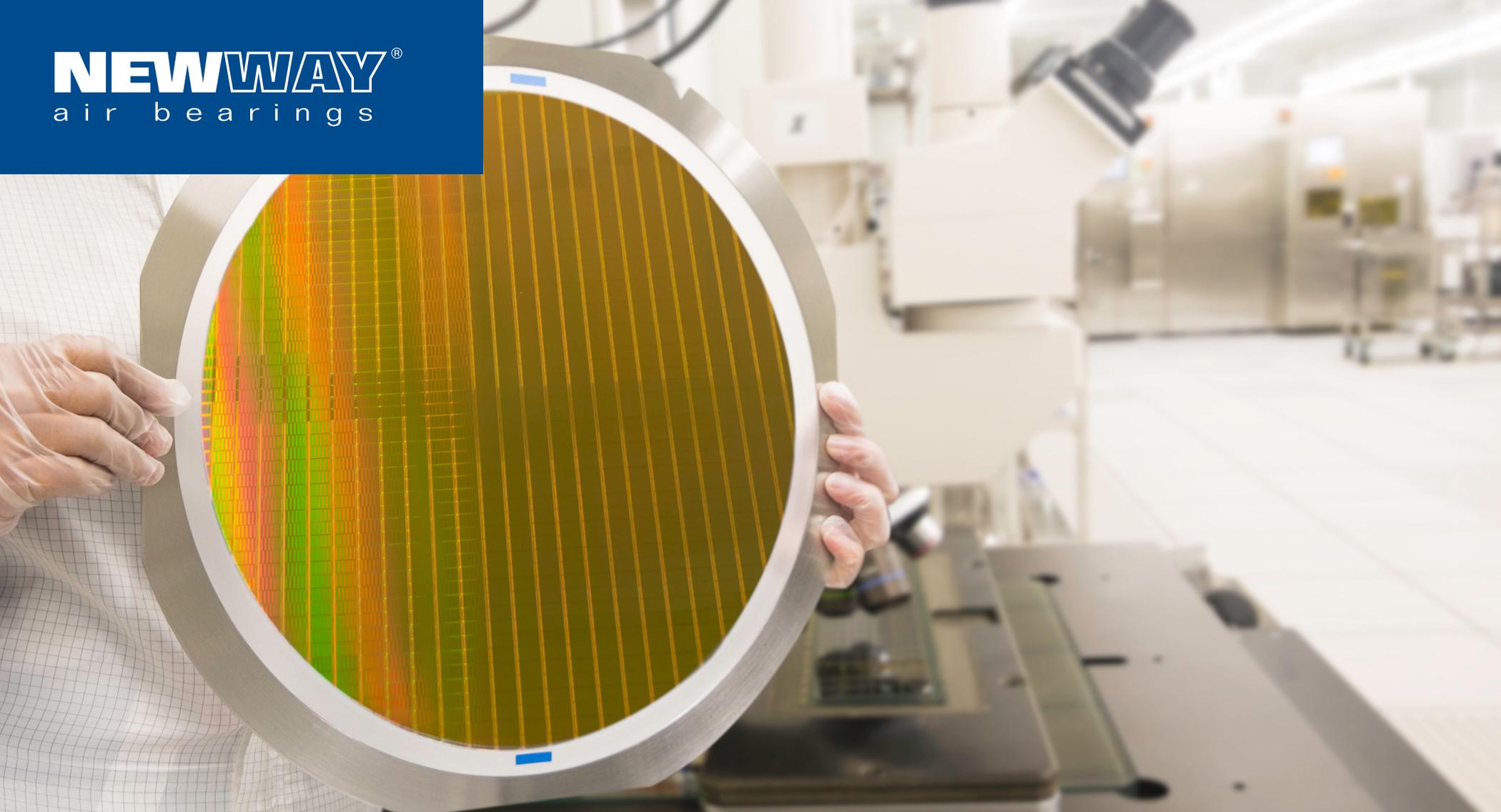
Vapor Deposition is a category of manufacturing techniques for thin films and electronic coatings, and is one of the foundational processes in semiconductor manufacturing. As its name suggests, deposition coats conductive materials onto a prepared surface —typically referred to as a substrate— via use of gasses or chemicals called precursors.

After the semiconductor surfaces have been prepared through deposition, numerous etching techniques will be used to selectively remove layers to create the final circuit design. Etching can take the form of either “dry” or “wet” etching, and each process is entirely dependent on time and rate control in order to ensure proper etching depth through the unmasked portions of the substrate.

How Porous Media Air Bearings Deliver

Deposition and etching both occur under conditions which can be extremely detrimental to traditional contact motion technologies like roller and ball bearings. This is even true of the sealed, deep grooved models specifically designed for these applications. High-temperature operation, high-speed machine motion, and hundreds of thousands, if not millions of cycles induce wear and tear on contact bearings. Even under ideal conditions, contact bearings will struggle over time to meet the current tolerances of the semiconductor manufacturing industry, as current chip architecture is now measured on the nanometer scale.

Porous Media air bearings provide the longevity, speed and precision to accurately position vapor deposition and semiconductor etching stages. Our flat round and flat rectangular bearings have found multi-decade success as the foundation for high-speed machine stages. Because there are no contacting components, this means no wear and tear and hysteresis-free positioning, with a motion tolerance limited only by the encoder and motor which run the stage.



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Lapping and Polishing

Lapping and Polishing

The Challenge

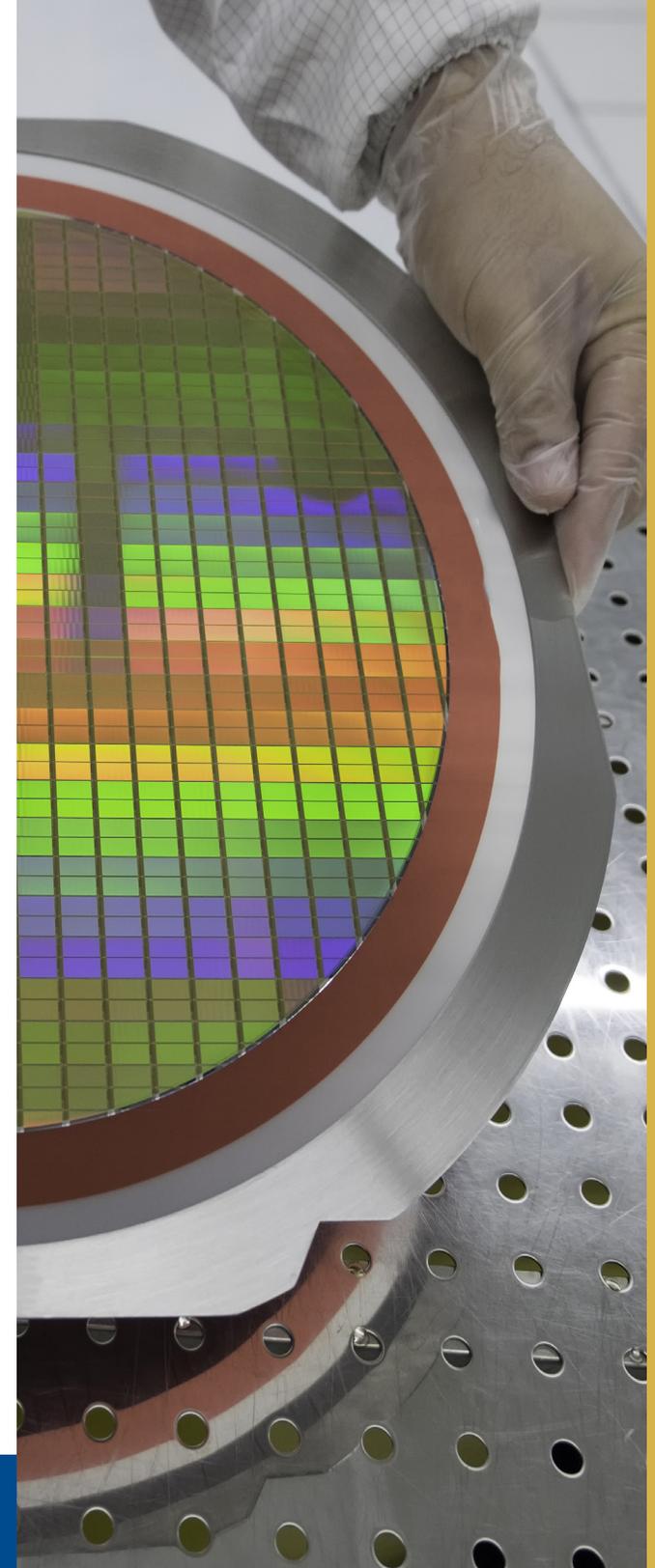
The process of lapping and polishing a sheet of pre-processed semiconductor wafers is a vital step in the manufacturing process. Before a wafer can be etched, the excess material from the deposition stage must be removed. Lapping or grinding is performed in much the same way as it would be for any precision machined component where flatness is a primary concern.

For semiconductors, a counter-rotating lapping system is often employed, during which a non-corrosive abrasive removes surface material in a precise, controllable manner. This not only ensures complete parallelism between surfaces, but also removes mechanical defects and residual stresses in the silicon, like that which might remain from when the chips were separated by an electronics saw.

How Porous Media Air Bearings Deliver

In order to lap and polish a wafer sheet, the wafers must be secured to a platform and allowed to counter-rotate against the lapping surface and the abrasive slurry. The most effective way to secure the wafer is via vacuum. While our air bearings are primarily known for their positive pressure operation in order to create a micro thin air gap, their operation can be reversed, allowing the air bearings to vacuum replicate themselves against a surface without needing to hold the sides in a traditional machining chuck.

Inconsistent vacuum, like that applied by an orifice bearing, can cause the wafer to contact the grinding surface at an angle and ruin a production asset. The entire surface of our air bearings create a vacuum pull due to their micro-perforated graphite structure. Thus, the vacuum remains consistent across the wafer structure, and ensures a clean, parallel surface once finished.



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FOR THE NEXT GENERATION OF
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Wafer Inspection

Wafer Inspection

The Challenge

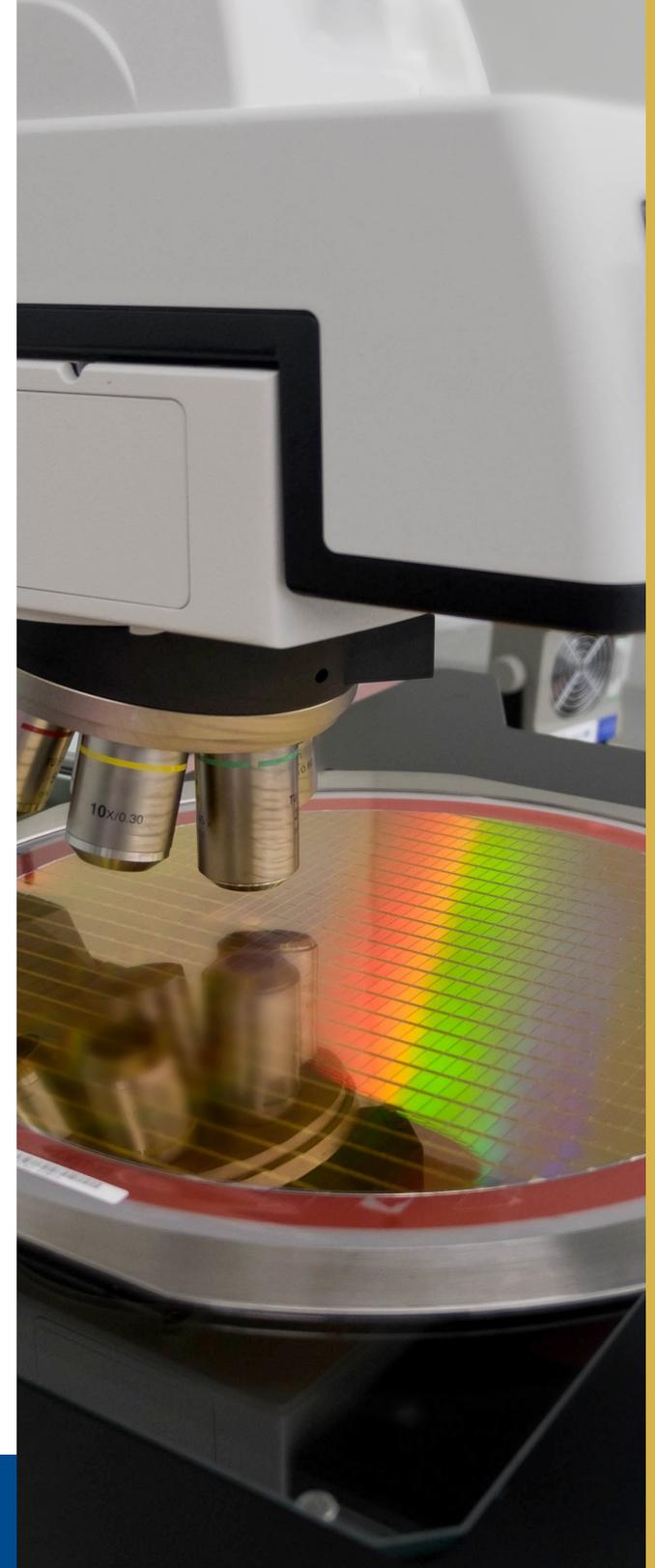
Inspection systems are among the most crucial steps in a manufacturing process, ensuring your quality control standards are executed, and deviations beyond established tolerances are identified. For semiconductor manufacturing, inspection systems primarily identify random defects. These include particles which have become embedded in the wafer itself, or systematic defects in the masking and etching process, which will propagate across an entire batch of dies. Inspection stages can be automated or manually controlled by an operator, but by any method, achieving nanometer-level positioning and accuracy is essential.

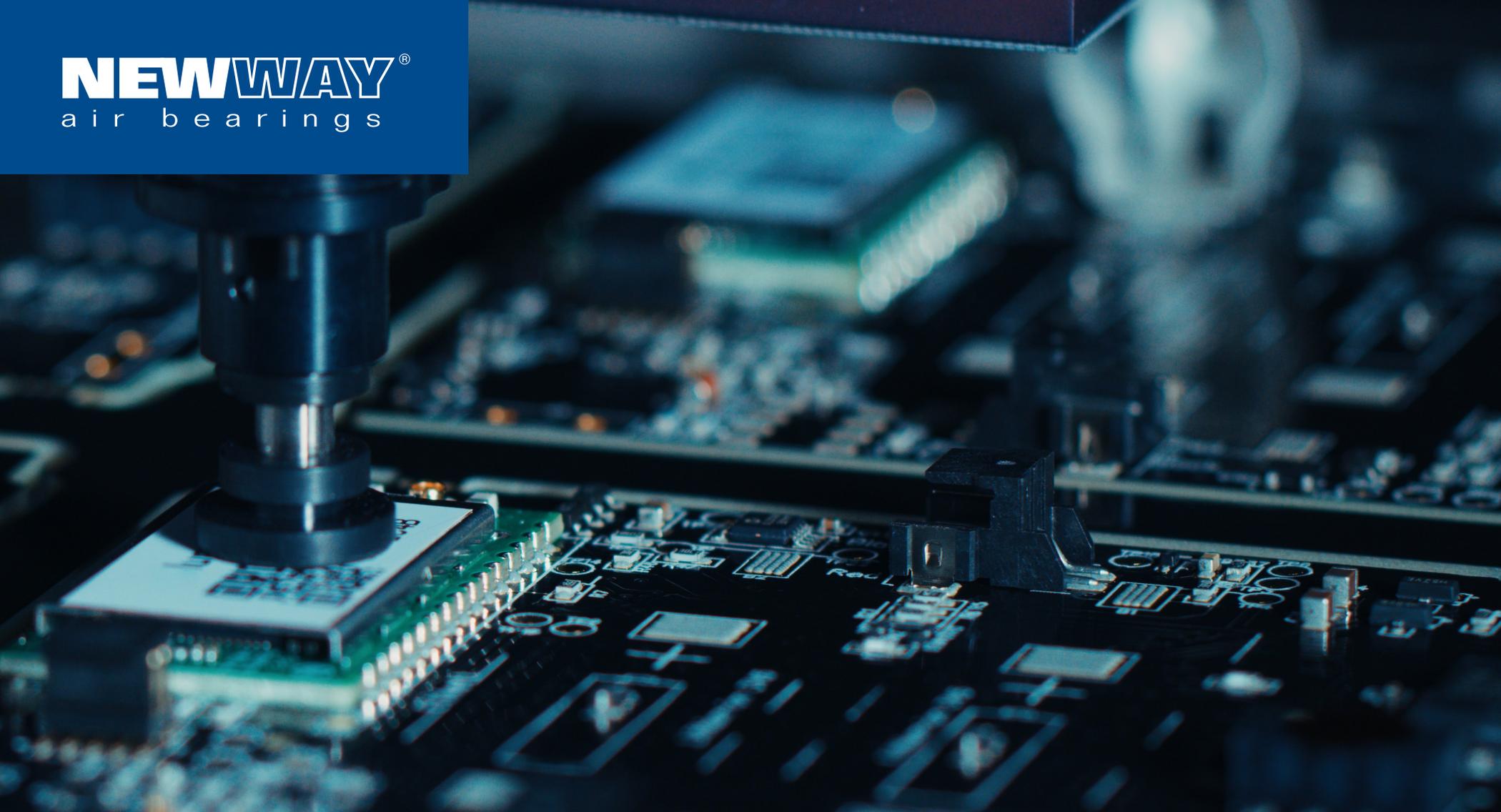
How Porous Media Air Bearings Deliver

Our Porous Media air bearings were originally developed for Checkmate Coordinating Measuring Machines (CMM's), and still represent the pinnacle of precision motion for inspection systems. Because air bearings feature no internal components with their own inertia, air bearings never overshoot, and can be positioned with linear and rotary accuracy on the order of nanometers and arcseconds.

Air bearings may be configured for linear motion along rails or in XY gantry configuration. The bearing face also acts as a submicron filter, providing cleanroom compatibility, and allowing wafers to be floated directly on the bearings themselves without harm or stress to the silicon substrate.

For flatness control of the inspection system —like that which might be necessitated when using a capacitance probe— air bearings can be used to form a precision XY platform, with 3 bearings to define the plane of motion.





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Pick and Place

Pick and Place

The Challenge

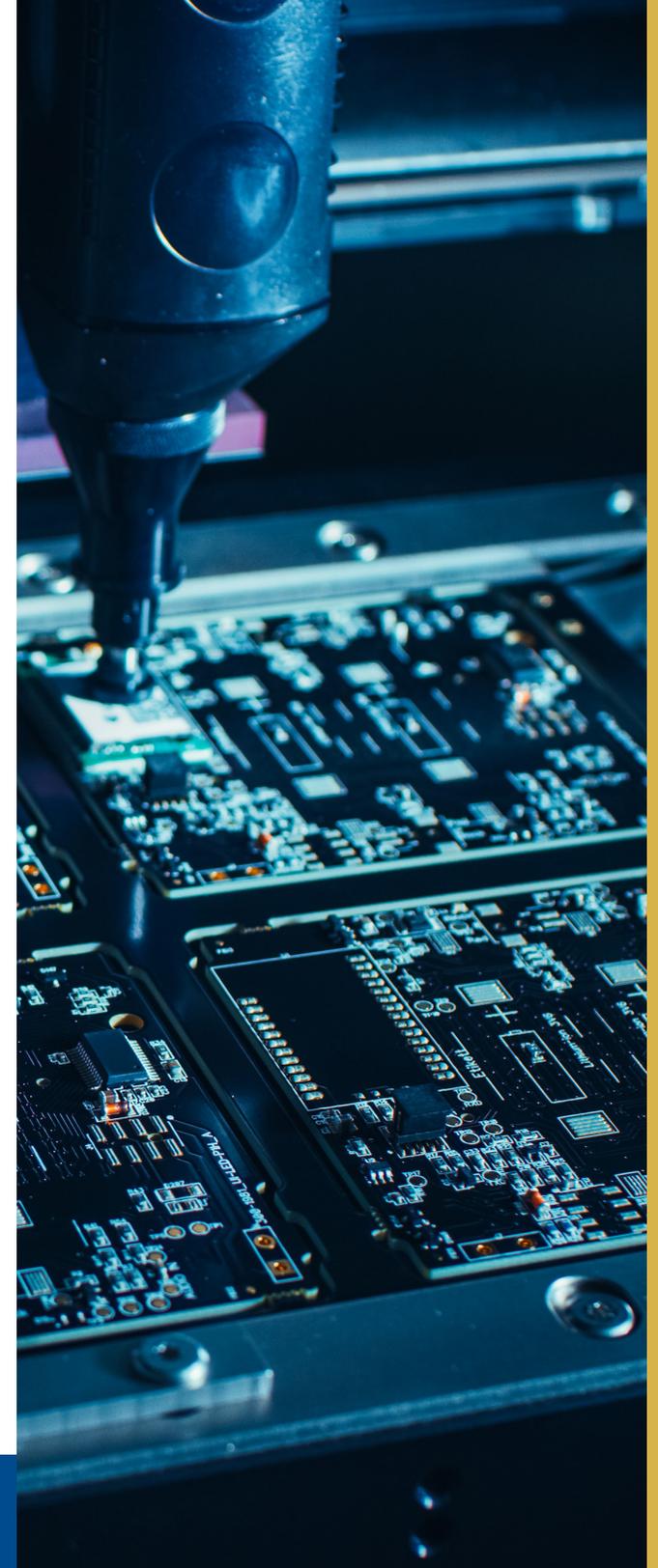
After semiconductor wafers have been separated into the individual dies or chips, pick-and-place systems are utilized to position the components on printed circuit board (PCB). These systems are used for everything mounted on the PCB; capacitors, resistors, and virtually all integrated circuits.

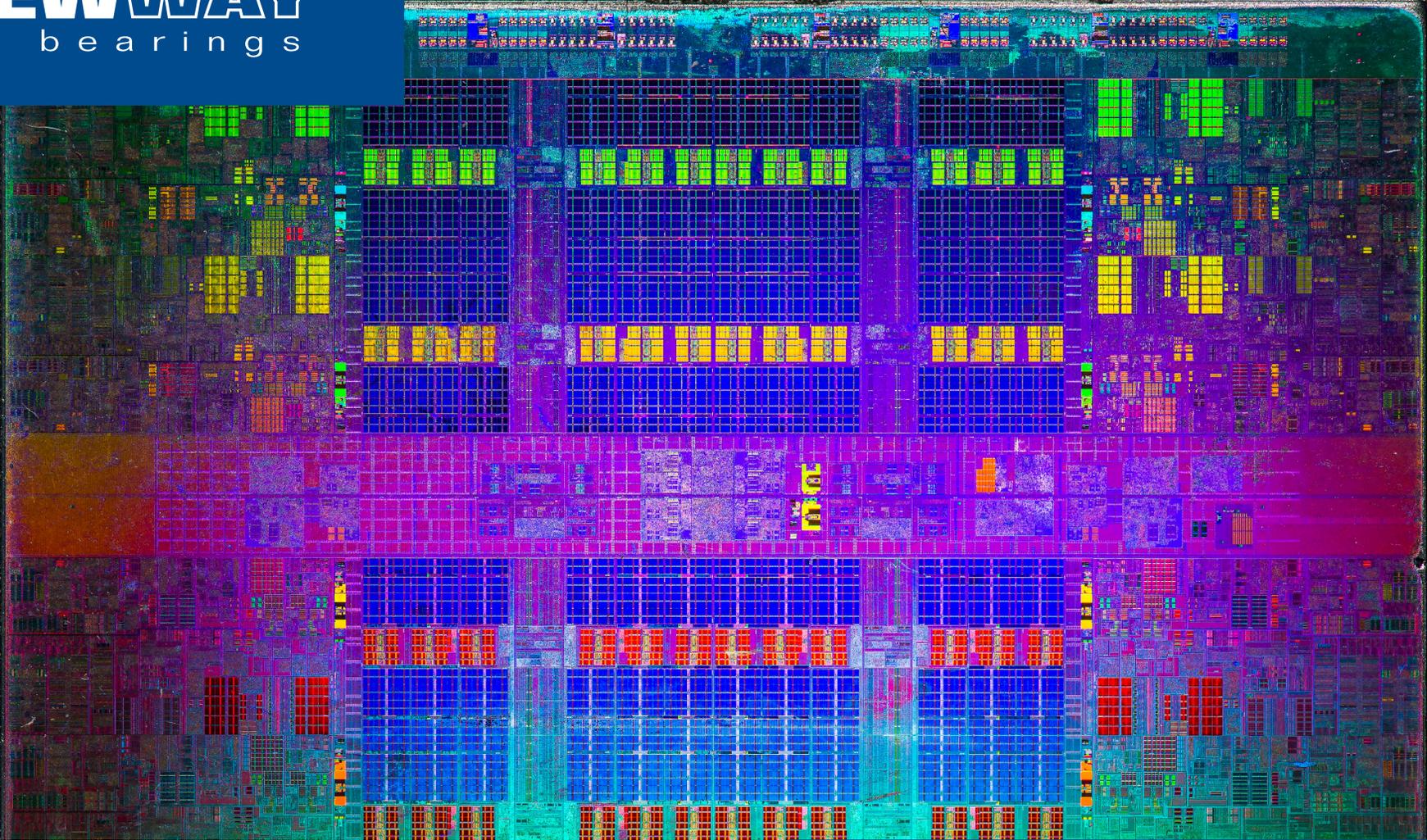
These machines operate at speeds far faster than a human operator could perform the same task, and their precision of motion in a three dimensional space is paramount for placing components within tolerance. This prevents risking any further points of quality failure at this late stage in the manufacturing process.

How Porous Media Air Bearings Deliver

Porous media air bearings have a proven track record of underlying XY and even XYZ gantry configurations for precision motion along multiple axes. Our linear slides, especially End Supported Linear Air Slides can be stacked for XY configurations. By fixing the stage and moving the guide bars, motion can also be controlled along the Z axis.

These linear motion systems are highly reliable for pick-and-place systems due to their vacuum replication along the guide bar. This offers unparalleled straightness of motion even along multiple meter long guideways. Additionally, since our Porous Media systems are not constrained by the need to overcome friction, our bearings can exceed the speeds of linear bearings by up to an order of magnitude.





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Photolithography

Photolithography

The Challenge

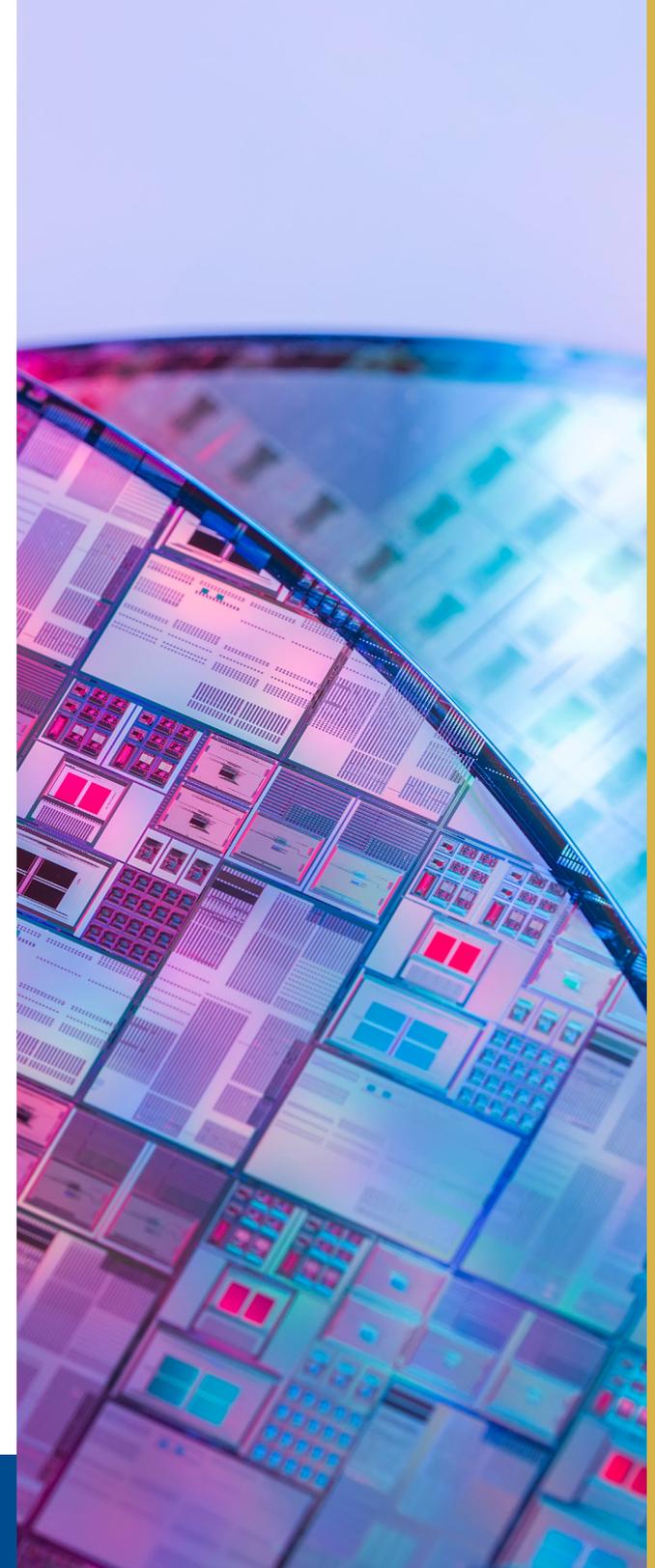
Photolithography represents potentially the most important component in the semiconductor manufacturing process. After etching and lapping the semiconductor wafer, the component is coated with a photoresist and placed in the lithography stepper. Through a complex series of lenses, the pattern of the circuit is projected onto the substrate, etching it into the photoreactive surface and creating the blueprint for the overall circuitry, which will be etched in later.

Lithography is an incredibly precise process, relying on minute motions of the stepper stage, as the wafer is moved in increments to project the blueprint onto each consecutive die. This continuous motion induces wear and tear on conventional contact systems, even those designed for longevity under these conditions.

How Porous Media Air Bearings Deliver

As we've already established, Porous Media air bearings are an excellent choice for XY gantry stages and high-speed machine motion. What you may not know is that our air bearings are also readily available, and suited towards retrofitting existing contact systems. New Way even has experience retrofitting lithography steppers specifically.

New Way Air Bearings is proud to manufacture a line of custom flat air bearings, off-the-shelf compatible with the Canon FPA I4, IW or I5 models. These can be retrofitted and installed in concert with an authorized rebuild-er, or with Canon themselves. If your business already uses a different OEM for your lithography processes, our experience is highly transferable, and we can work to develop the custom air bearing stage for your system. We will even provide on-the-ground assistance with your rebuild-er for a seamless integration of our non-contact technology.



Reimagining Semiconductor Manufacturing

Air Bearings Offer Unique Solutions to the Challenges of Semiconductor Production, Inspection and Packaging

Semiconductor manufacturing underpins our modern way of life, empowering everything from our cell phones and cars to decentralized cloud computing arrays. Semiconductors, both big and small are difficult to produce, requiring a time intensive process which demands precision and intense cleanroom controls throughout.

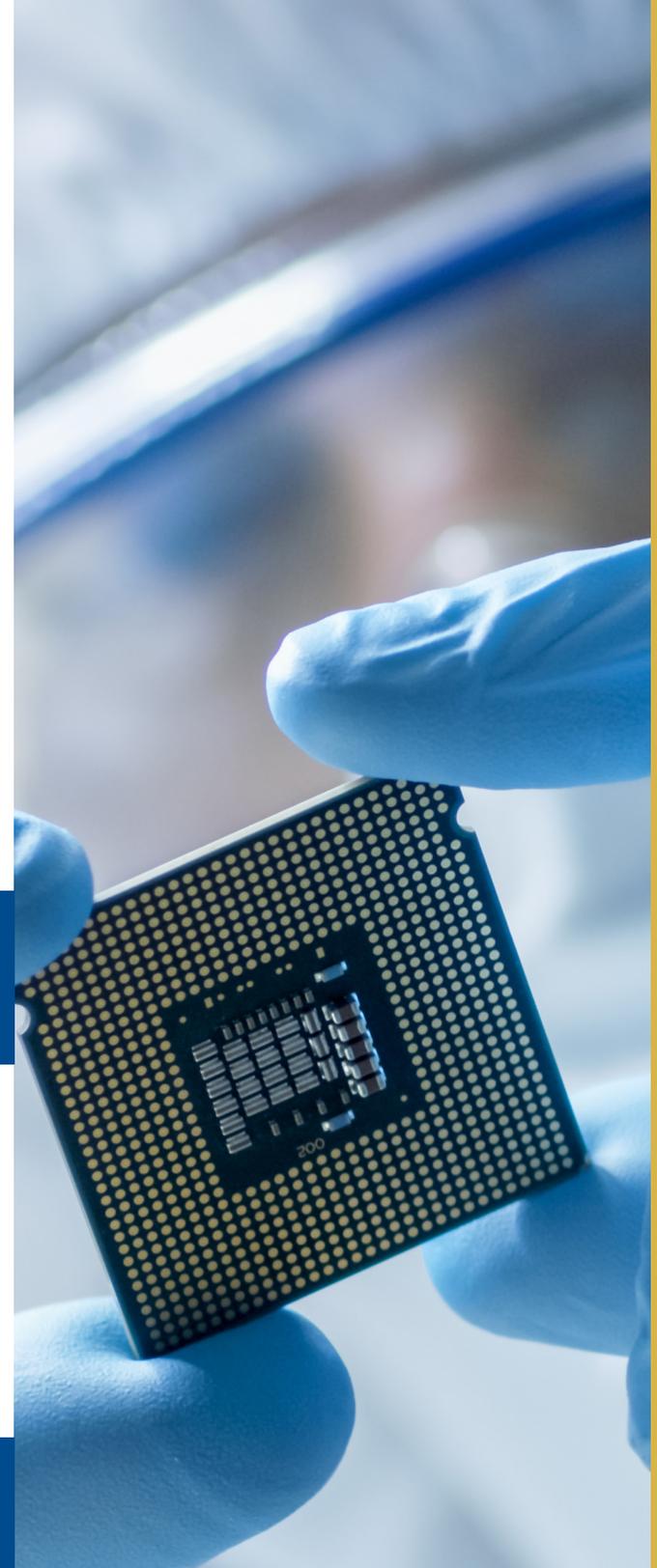
Improving the production of semiconductors and wafers is not without challenge, but there are ways to reduce downtime and increase throughput for every stage of the process.

As we've discussed in this eBook, porous media air bearings offer speed, durability, and precision across every aspect of the manufacturing stages, including:

**Vapor Deposition and Etching | Lapping and Grinding |
Wafer Inspection | Pick and Place Systems | Photolithography**

With a broad array of standardized products, and with a team on staff for fully customized solutions, New Way Air Bearings is ready to help build the next generation of additive manufacturing on frictionless media.

If you have questions about our products or you're ready to move forward with an application, please visit us at www.newwayairbearings.com. Or, contact us directly for a complimentary consultation.



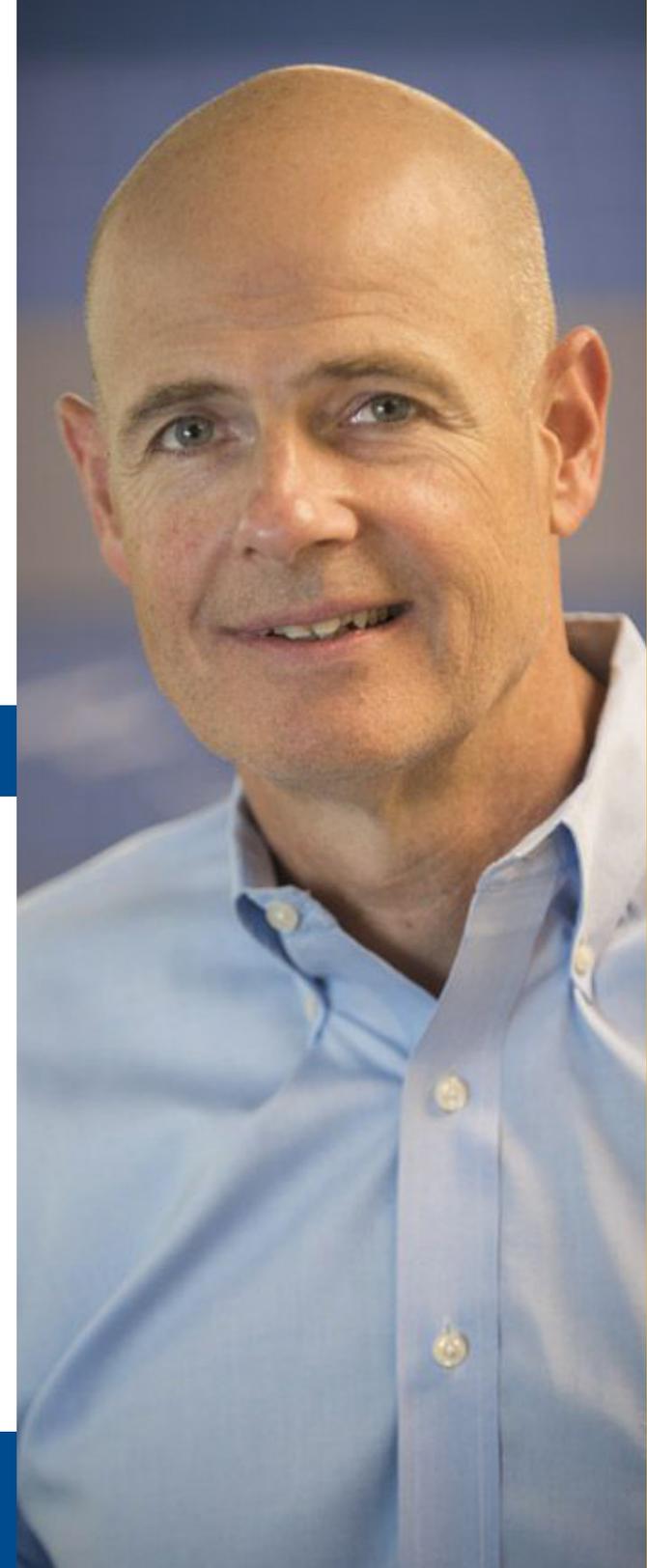
About Drew Devitt

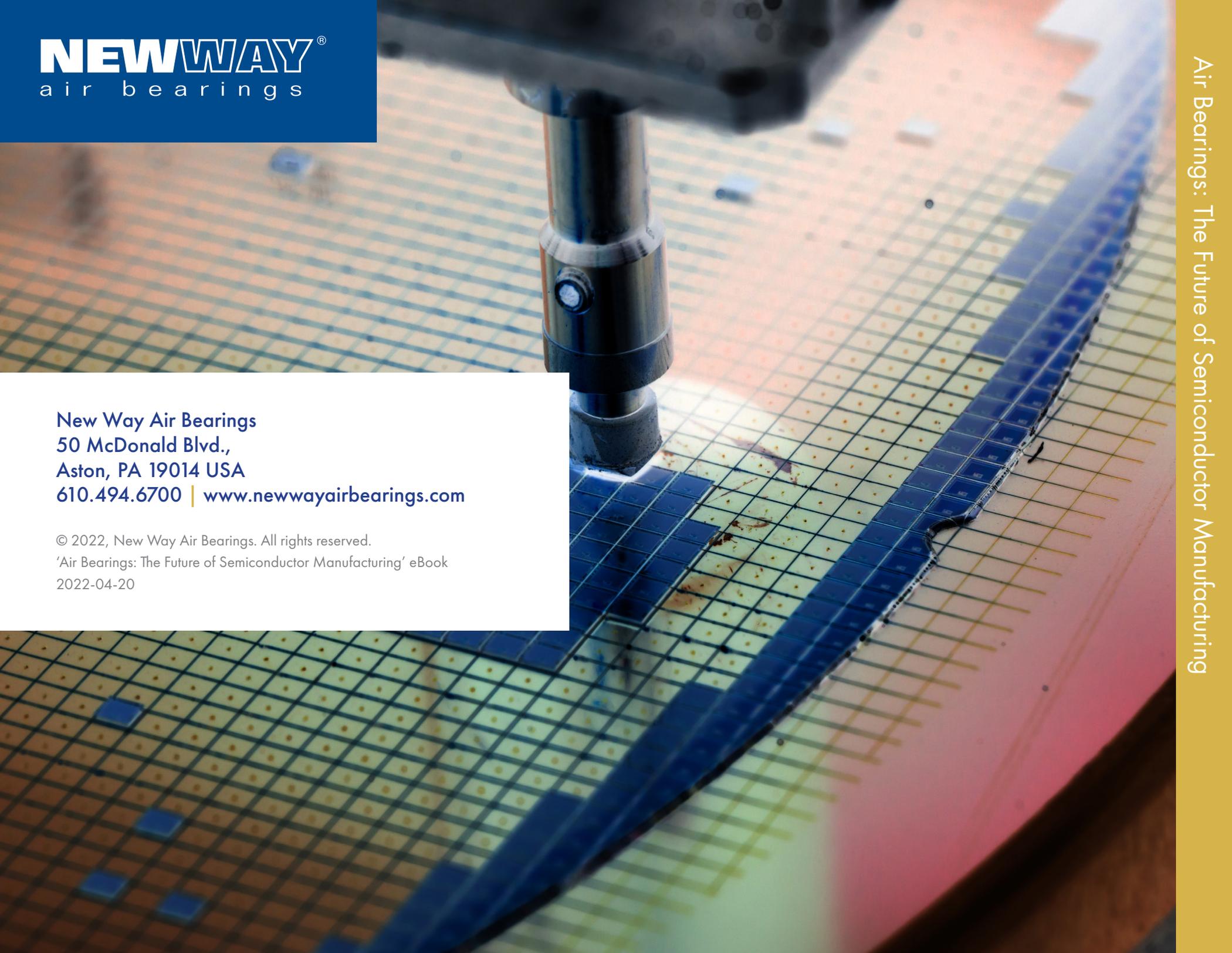
Drew Devitt founded New Way Air Bearings in 1994 to realize business success through the commercialization of Porous Media Air Bearing Technology.

From the time of New Way's inception, Devitt, as CTO, has maintained its research efforts, and its connections with research and academic institutions, in order to foster the continued development of air bearing technology and the dissemination of the knowledge gained. Devitt is a major figure in the world of precision and was elected President of the American Society of Precision Engineering (ASPE) for the 2007 calendar year. He holds a Bachelor's Degree in Business Administration.

About New Way Air Bearings

New Way® Air Bearings, Inc. is the world's leading independent designer and manufacturer of modular air bearing products, and the recognized provider of Porous Media™ air bearing solutions, sold in over 30 countries worldwide. The company manufactures a standard line of modular, off-the-shelf components as well as custom products, and is ISO 9001:2015 Certified. New Way is headquartered in Aston, Pennsylvania, USA, just 15 minutes from Philadelphia International Airport.





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air bearings

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'Air Bearings: The Future of Semiconductor Manufacturing' eBook
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