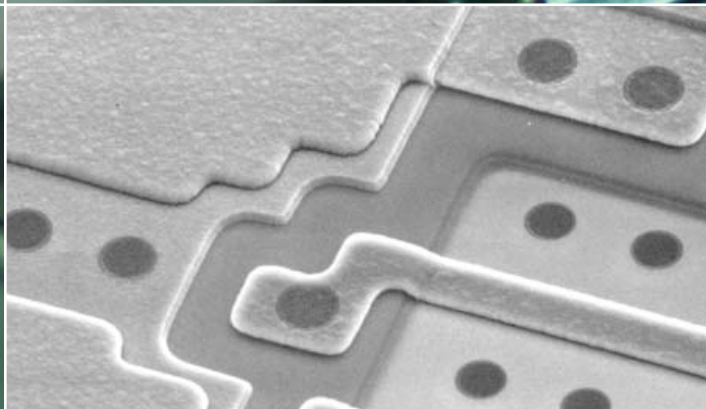


Teledyne DALSA Semiconductor
**MEMS FOUNDRY
LEADERSHIP**

CREATING POSSIBILITIES | DELIVERING PERFORMANCE





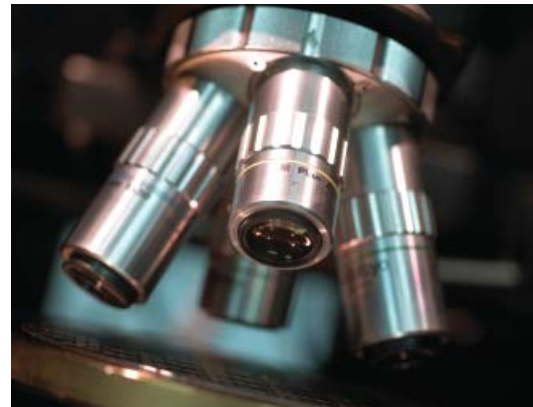
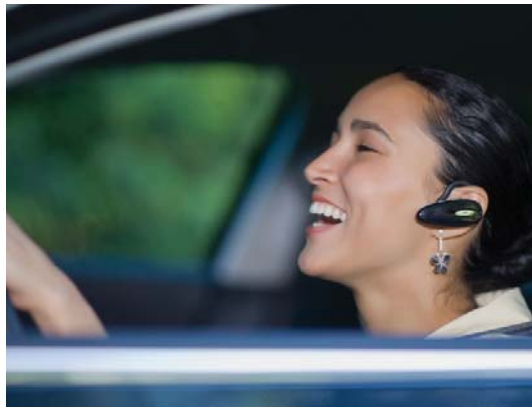
Shaping the future

Teledyne DALSA is one of the world's foremost pure-play MEMS foundries. *What sets us apart?* Without a doubt it is our mastery of a vast and unique wafer fabrication repertoire. Years of devoted R&D have earned us a profound understanding of the physics and materials science that make MEMS possible. Our MEMS process module portfolio is recognized as exceptional and represents true competitive advantage for our customers. Proof of our abilities is our enviable track record of moving customer designs to volume production quickly and smoothly.

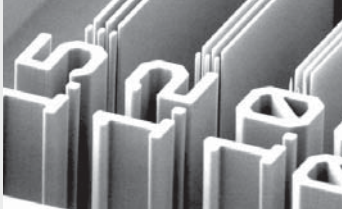
Teledyne DALSA puts all its experience at your command to bring your breakthrough designs from conception to reality. Our rare ability to optimize architecture, performance, and reliability serves high-volume, mission-critical microsystems in a wide range of industries.

Further differentiating Teledyne DALSA are our design capabilities not only with MEMS themselves, but with the high voltage drivers often needed for MEMS devices' optimal performance. Teledyne DALSA's unmatched custom MEMS and HV ASIC design service can supply components or complete solutions to bring your MEMS applications to their maximum potential.

With our rigorous ISO/TS 16949 registered quality system and our dedication to customer service, we offer a commitment to success that is matched only by your own.

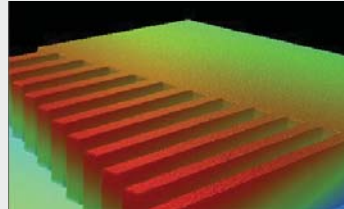


Teledyne DALSA offers customers a sophisticated toolbox of dozens of proven and patented process modules and techniques, as well as excellence in value added services including custom design, test development, and advanced packaging.



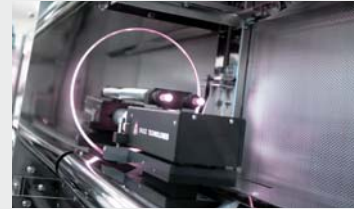
Si DRIE

- High etch rates (35 $\mu\text{m}/\text{min}$)
- Depth to 875 μm , high aspect ratios
- Angle capability (e.g. 60°)



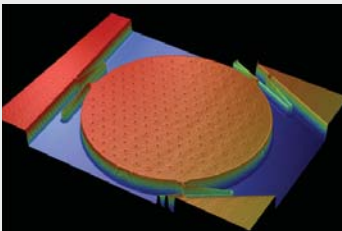
Anhydrous HF Release

- Proprietary recipes eliminate stiction and residues



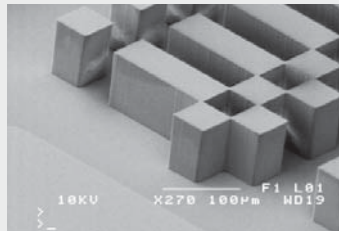
Low Stress SiN

- Mech. Stress = 175 MPa
- Breakdown Field >4.8 MV/cm



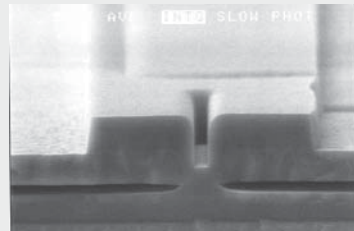
ISDP

- Resistivity 0.65 $\mu\text{Ohm}\cdot\text{cm}$
- ISDP Stress = -25 MPa
- Gradient = 3.0 MPa/ μm



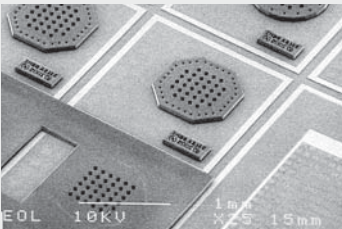
Thick Polymers

- Coat thickness: <40 μm
- Develop: aspect ratio 5:1, 1 μm features



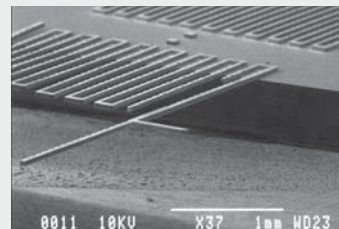
Low Temp SiO₂, PECVD, SOG

- Low Temp SiO₂: 300 nm – 1 μm
- PECVD: 100 nm – 10 μm
- Clean release in HF
- SOG: 100 nm to 2.0 μm ; fast release in HF



Wafer Bonding

- Si-Si, Si-SiO₂, SiO₂-SiO₂, eutectic, solder, thermo-compression, glass frit sealing, anodic, vacuum, plasma-assisted, polymer and more



Metals and Plating

- AlCu, AlSiCu, Ti/TiN, Ge, Cu, Ni, Pd, W, and more
- Electroless Ni and Pd plating on Al substrates



Grinding and Dicing

- Membranes ground to 30 μm
- Pad expose steps
- Dicing of mechanically released structures, no lid wafer required



Our Exceptional MEMS Toolbox

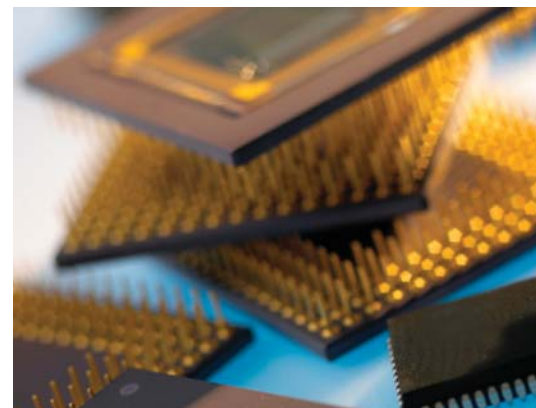
Teledyne DALSA offers customers a truly unmatched toolbox of dozens of proven and patented process modules and techniques.

We offer key [surface and bulk micromachining](#) techniques for Si including [high aspect ratio](#) and [high throughput DRIE](#), with depths to 875 μm and etch rates up to 35 $\mu\text{m}/\text{min}$ for 1:1 aspect ratio cavities. For [through silicon vias](#), our DRIE capabilities include aspect ratios of 23:1 and 90-91° profiles with etch rates of 9 $\mu\text{m}/\text{min}$ as well as fine etching with sidewall roughness <90 nm for aspect ratios up to 35:1 with control of vertical profiles (89.7-90.3°) and tilt <0.5°. We also offer other angles such as 60°, providing an alternative to anisotropic wet etch with high throughput and more design flexibility.

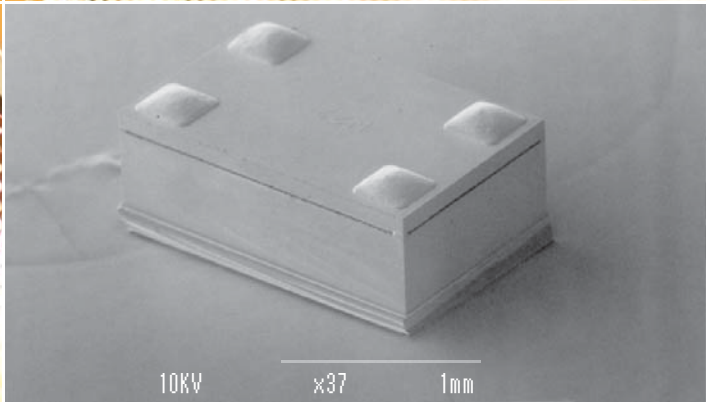
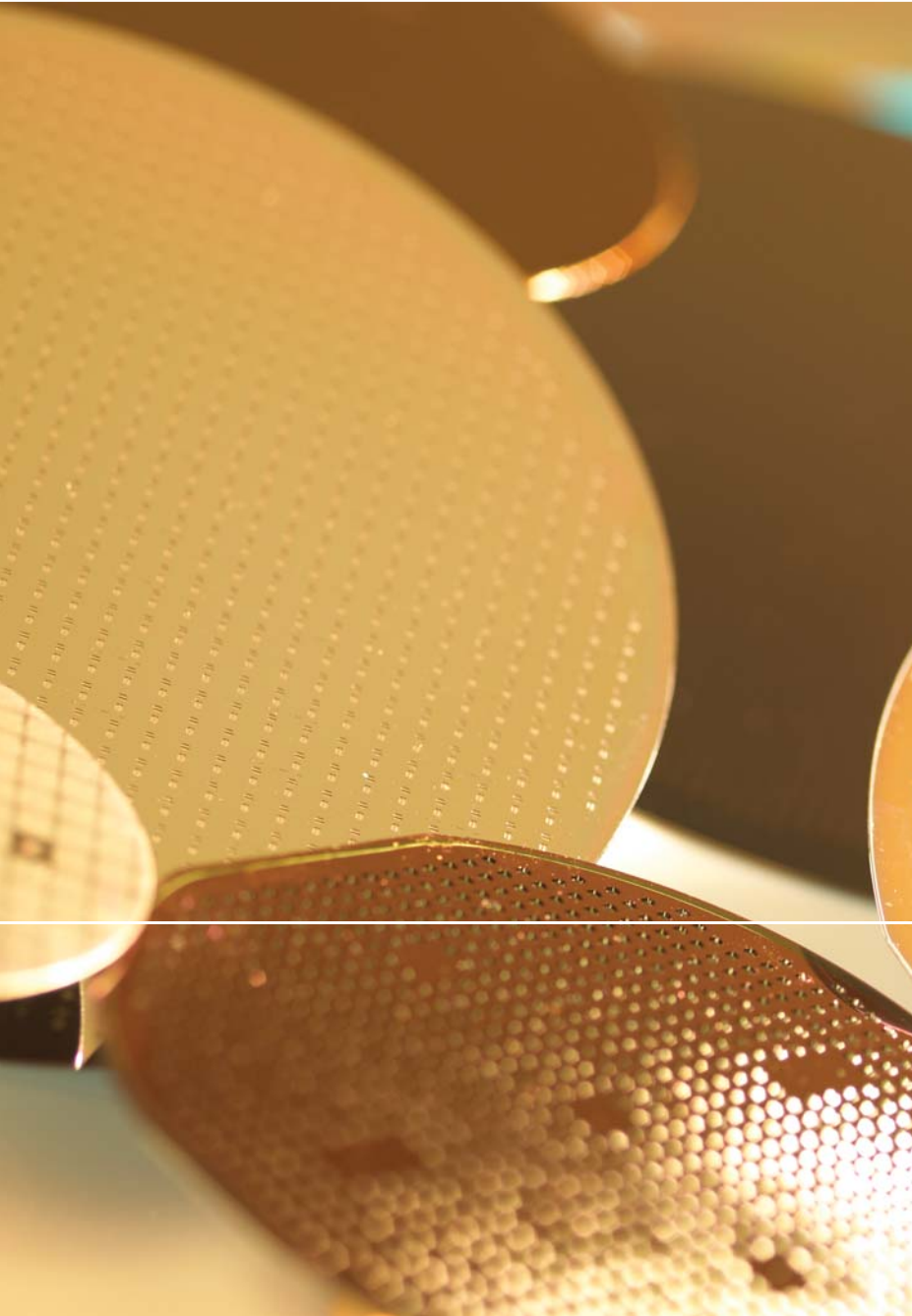
We excel in processes for [low temperature/high conductivity in-situ doped polysilicon](#) as a structural material and for [TSVs](#). Our proprietary [anhydrous HF release](#) recipes eliminate post-etch stiction and by-product residues. [Low stress SiN](#) is another of our specialties, both as protection during anhydrous HF release, and as a structural material to balance stress when combined with other silicon features. We also provide extensive high aspect ratio [thick sacrificial](#) or [permanent polymer processing](#) both photoimageable and hard mask, and patented techniques for [thin film deposition](#).

Our unique process toolbox also includes [solder bumping](#) (including Ni/Pd UBM), [CMP](#), [backgrinding](#), and [dicing](#). The [electroless Ni and Pd plating](#) capability we offer on Al film provides the flexibility for both solderable and wire bond finishes on the same surface, as well as allowing tin-based bonding to other wafers. [Bonding](#) is an area of particular expertise for us, enabling a wide range of technology integrations; our vast repertoire includes Si-Si, Si-SiO₂, SiO₂-SiO₂, eutectic, solder, thermo-compression, glass frit sealing, anodic, vacuum, plasma-assisted, polymer and temporary bonding.

We are proud of our toolbox, but even more proud of our mastery of it. The greatest value Teledyne DALSA offers you is our ability to leverage and integrate individual foundry processes to bring your breakthrough MEMS designs into production. Read on to learn more about our technology for integrated MEMS.



Our commitment to research and process development gives us an immense range of capabilities in MEMS design, manufacture, and packaging.





Delivering the Future with Integrated MEMS

Teledyne DALSA is renowned for its extensive experience with advanced fabrication strategies such as stacking circuits to reduce package size or combining MEMS and CMOS wafers to integrate sense and actuation with logic circuits. With years of experience in [3D](#) and [wafer level packaging](#) technologies including [through-silicon vias](#) and a wide range of [bonding techniques](#), Teledyne DALSA can help you transcend traditional design limitations.

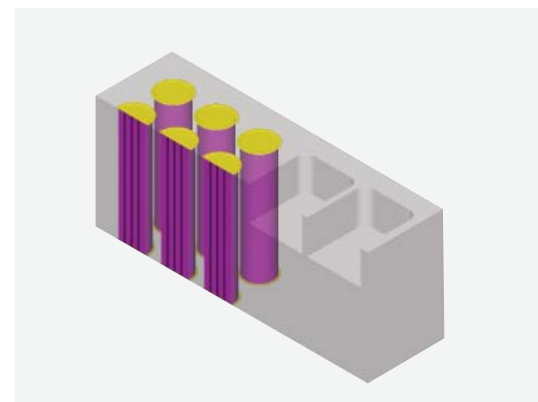
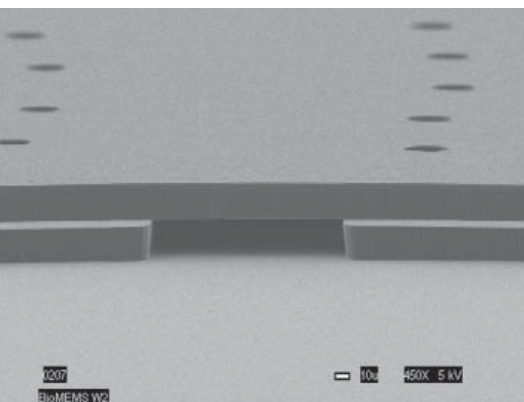
From RF chips for cellphones and optical cross-connects for telecom to chemical and particulate sensors for smoke detectors, inertial motion sensors for game controllers, automotive pressure sensors, and microfluidic devices for miniaturized medical systems, integrated MEMS enable innovations that reduce both size and power consumption even as they increase performance.

TSV - Teledyne DALSA has offered high aspect ratio TSVs for years (Depth > 400 μm) with HV operation, thermal oxide isolation, options for Ni/Pd plating and deep cavities, and standard dicing without the need for a "pad expose" step. We are augmenting our existing via-first low-resistivity ISDP fill process (typical resistance < 1 Ohm for 430 μm depth, capacitance < 10 pF) with a higher performance copper fill process with even lower resistivity and higher thermal dissipation for faster operating frequencies and higher power density. This new copper fill process is well suited to volume production with high etch rate Bosch DRIE processes, which can reduce DRIE step costs by up to 50%.

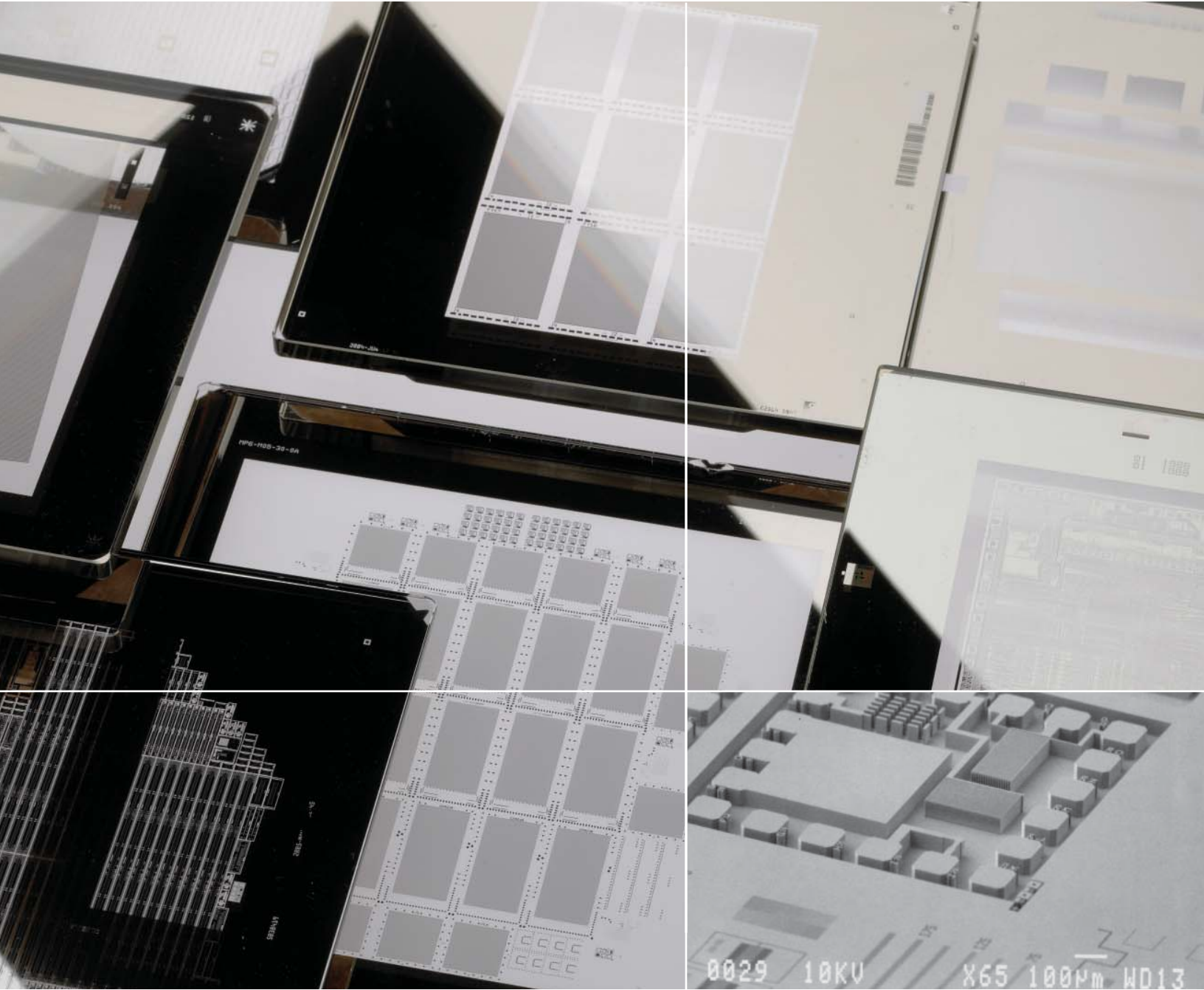
WLP - Surface mountable 3D ICs use wafer level packaging for dramatic size and form factor reduction with corresponding cost reductions, making them ideal for mobile applications. Teledyne DALSA offers advanced I/O options including μBGA , solderable pads, or standard pads for stacked die and co-package designs, with hermetic seals for oscillators, pressure and image sensors, and non hermetic for RF filters, microfluidics and Si microphones.

Bio-MEMS - Teledyne DALSA is uniquely positioned with our integrated MEMS, HV CMOS and imaging technologies to develop and manufacture Bio-MEMS and integrated life science applications. Teledyne DALSA's toolbox of micro-fluidic and HV-CMOS cells can be used to create revolutionary Lab-On-Chip technology platforms.

Our strength is in our ability to reach the high levels of integration needed in standalone point-of-care products. Our advanced packaging options and proven high-volume manufacturing capability make us your ideal foundry partner for the bio-MEMS designs that will change the future.



By integrating advanced MEMS structures with high voltage actuators and CMOS logic for communication and control in wafer-level packages, Teledyne DALSA enables our customers to productize their truly revolutionary design concepts.





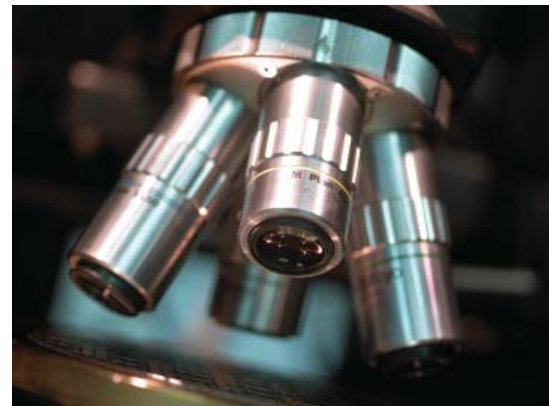
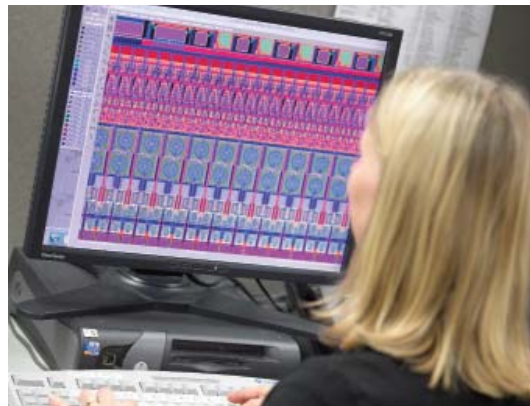
MEMS Design Services: You Imagine, We Deliver

What if you know what your MEMS solution needs to do but don't have all the development and design skills in your own organization? Simple. You can [have Teledyne DALSA design and build it for you](#). Through a process of close collaboration, we can take your ideas, sketches or CAD, and create a complete design, managing your custom project through detailed specifications, simulations, 3D views, MEMS layout, masks, prototypes, verification, characterization, and packaging, to full volume production.

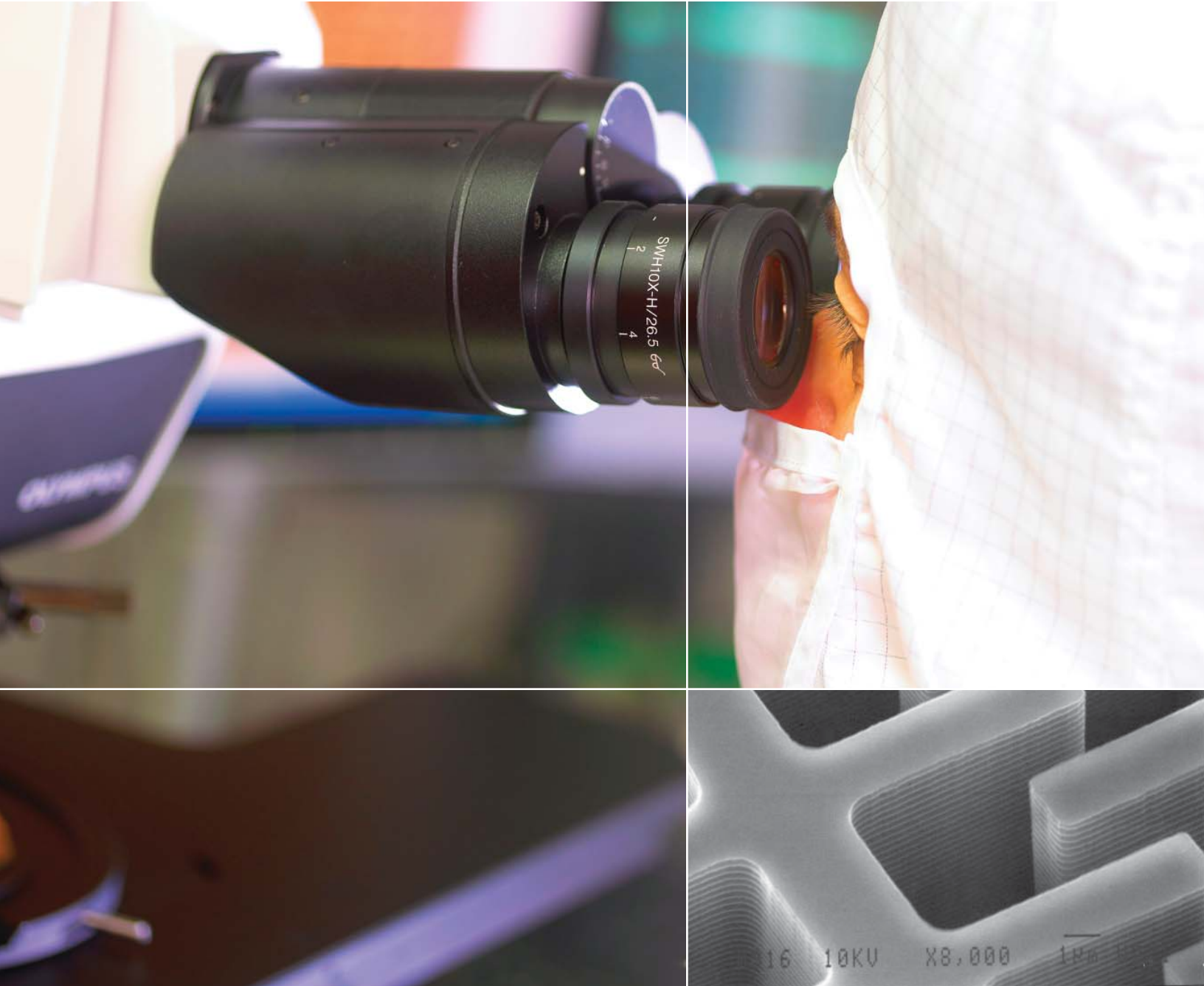
Take advantage of our years of [MEMS technology expertise](#) and our [specialized Engineering Design Assistance \(EDA\) tools](#) to turn your requirements into a [custom, purpose-built solution](#) with optimal, differentiating performance for true competitive advantage. With our unique combination of technology portfolio, dedicated design staff, and experience with not only MEMS but their integration with control logic and high voltage actuators, [we can minimize design iterations and development time](#), ensuring your concept meets specifications. Our services include design simulations, Finite Element Analysis, and automated Electrostatic Discharge analysis to help identify and avoid design and production issues and [maximize product yield](#). Our extensive experience and intimate familiarity with MEMS fabrication can bring your visions to reality more easily than you ever imagined.

Teledyne DALSA also offers design services for the [high voltage ASICs](#) that many MEMS such as inkjet print heads, micromirrors, and microfluidics require for operation. MEMS are components in larger systems; communication and control interfaces with other circuits are crucial to overall system performance. Without HV expertise, MEMS designers will be limited by generic, off-the-shelf HV drivers, making product optimization and differentiation difficult. But with our extensive experience in custom HV design, we can build complete [application-specific solutions](#) for you from the ground up with none of the compromises of off-the-shelf components.

Let Teledyne DALSA's custom design services help you seize the MEMS opportunities you see, even if you're not a MEMS designer.



When performance is critical, there is no substitute for a purpose-built solution. Teledyne DALSA's high custom MEMS design service gives you the benefit of all our experience with both MEMS and HV driver ASICs to deliver solutions with the precise specifications you need.





Commitment to Quality and Customer Service

Teledyne DALSA has supplied specialized wafers and device fabrication to a wide range of fabless and IDM organizations for more than 25 years. We operate over 41000 square feet / 3800 m² of clean rooms 24/7 and deliver over 100000 wafers per year. To meet the strong demand for our unique capabilities, Teledyne DALSA has also added a new 200 mm MEMS line to our existing 150 mm lines, significantly increasing capacity.

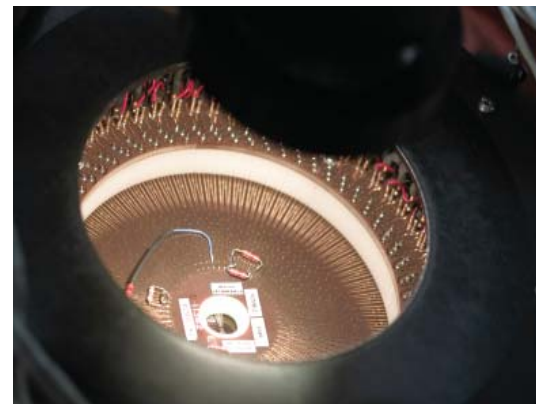
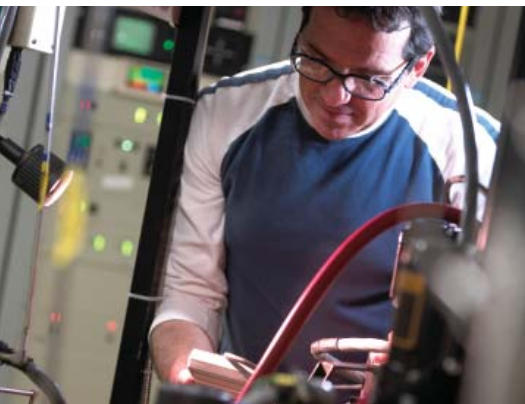
With a technology portfolio as wide and flexible as ours, with deliverables as varied as ours, excellence in planning, quality assurance, and customer interaction are not optional activities—they are fundamental business requirements. Only through the dedication of our engineers, technicians, and operators to exceptional project management, comprehensive resource planning, rigorous quality methodologies, and devoted customer communication have we achieved our global reputation for success.

Similarly, with our wide range of clients, dedication to confidentiality is paramount. Teledyne DALSA Semiconductor is proud of its reputation in assuring customer confidentiality and protecting customer intellectual property.

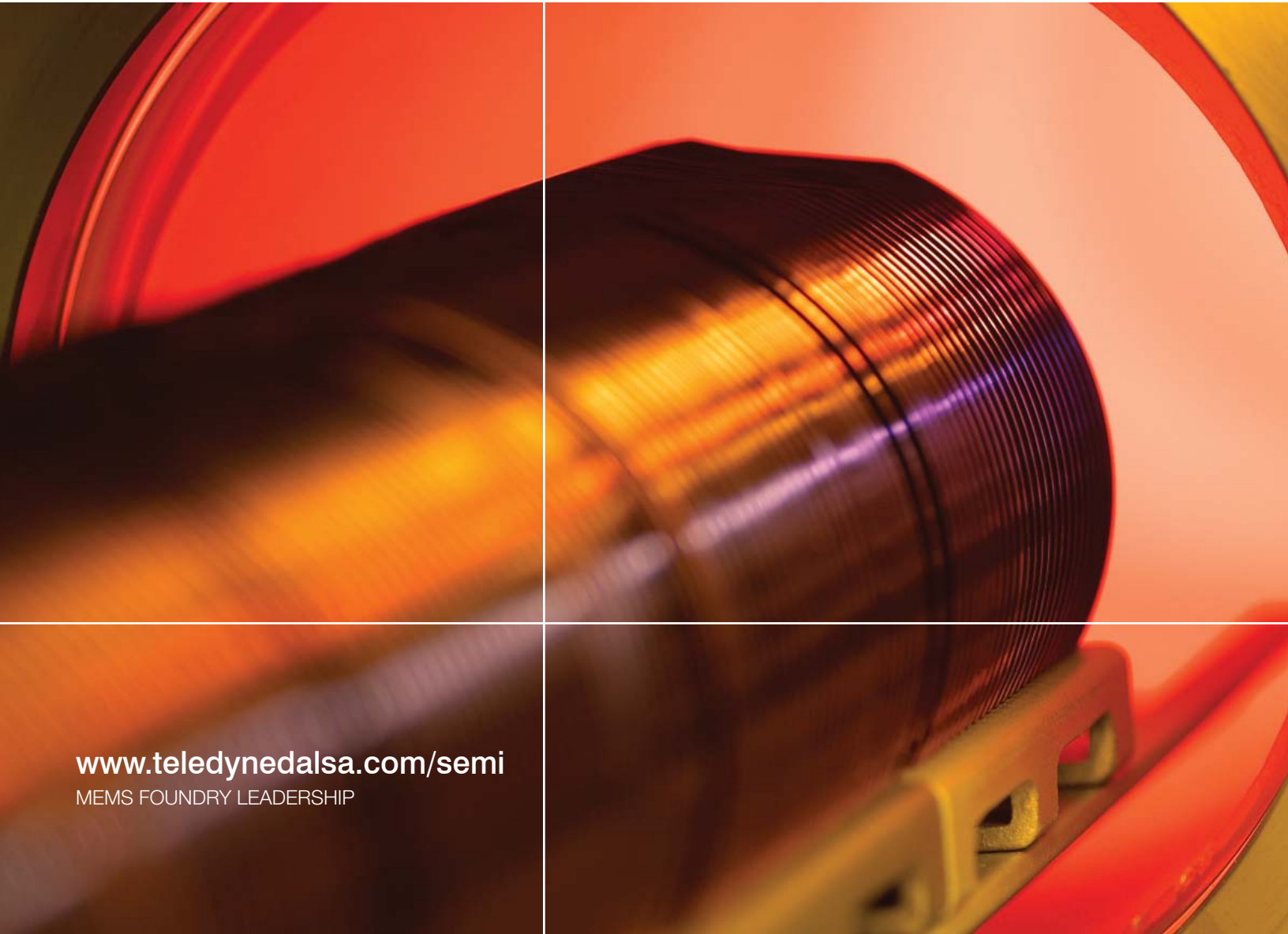
Our operational discipline is embodied in our quality program, which meets the highest standards. Our long history as a commercial foundry (rather than an experimental group) has embedded stringent quality control deep into our corporate culture. Highlights include:

- ISO/TS 16949 (includes ISO 9001) and ISO 14001 registration
- real time lot tracking with end-to-end traceability
- real time and online Statistical Process Control (SPC)
- microcontamination and ESD control programs
- reverse engineering and failure analysis services
- RoHS compliant

Contact Teledyne DALSA Semiconductor for your next MEMS project. Let us partner with you to create new possibilities and deliver new levels of performance.



Teledyne DALSA wants to help you succeed. As our customer and partner, we pledge to you the full benefit of our decades of specialist experience and attentive, professional, proactive customer service. Find out more about what our exceptional capabilities can do for you.



www.teledynedalsa.com/semi
MEMS FOUNDRY LEADERSHIP

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