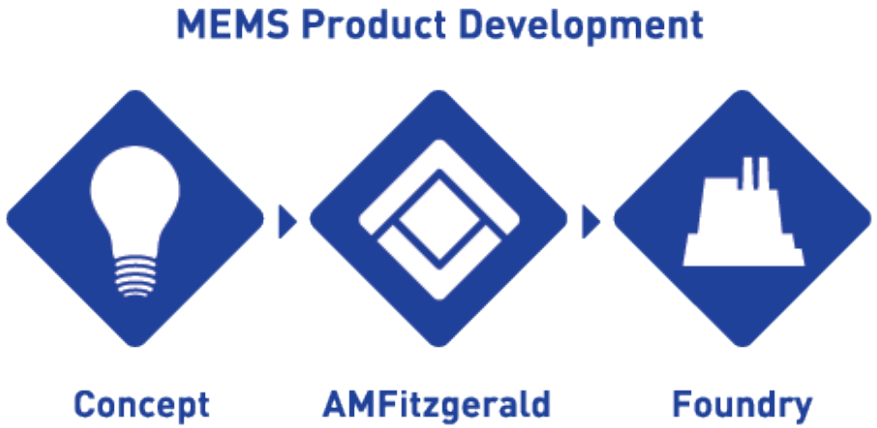
# Company Overview

**June 2011**

AMFITZGERALD
& ASSOCIATES

# Mission

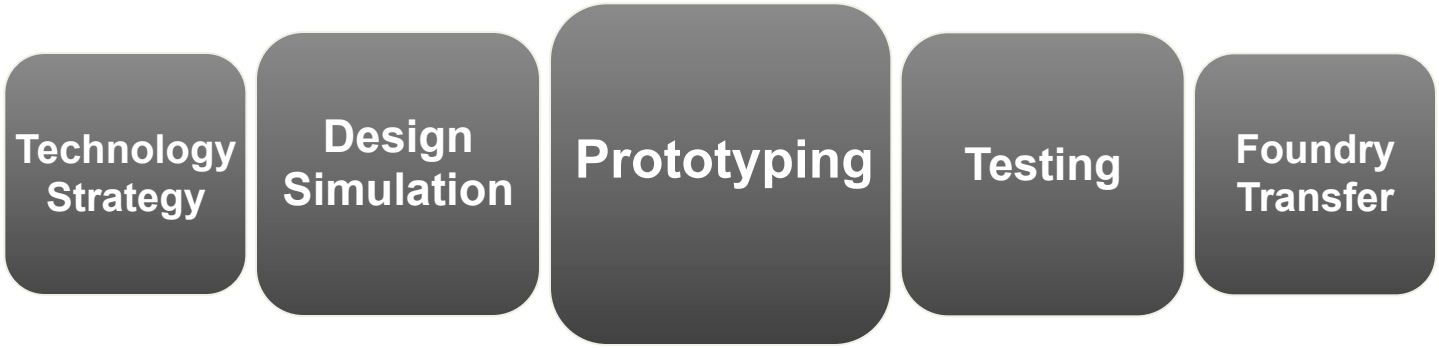



We turn your ideas into silicon.

# Company background

- Founded 2003 by Alissa M. Fitzgerald, self-funded
- Goal: become the premier MEMS product development firm
- Consistent growth, > 20% CAGR
  - Over 90 clients served to date
- Full-time staff of six
  - Three PhDs, two engineers, one admin
- Active member of the MEMS Industry Group

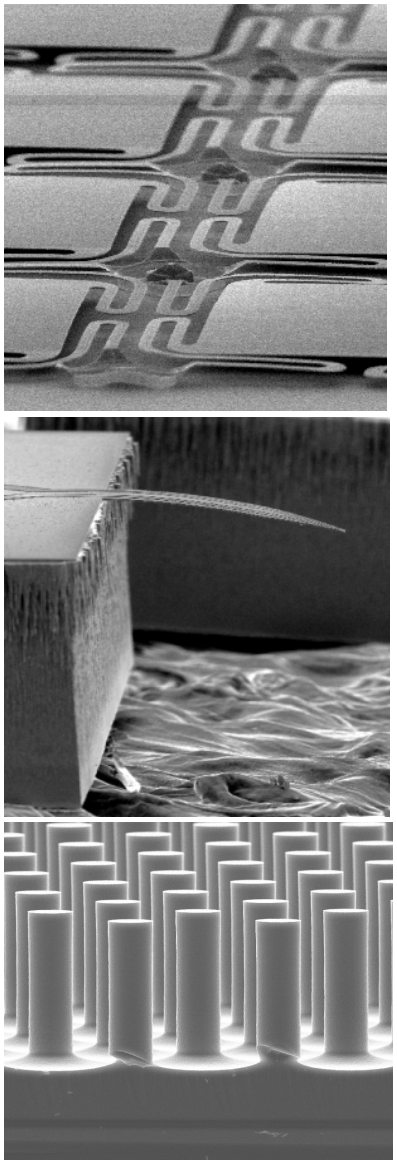
# Fully integrated services: concept to production



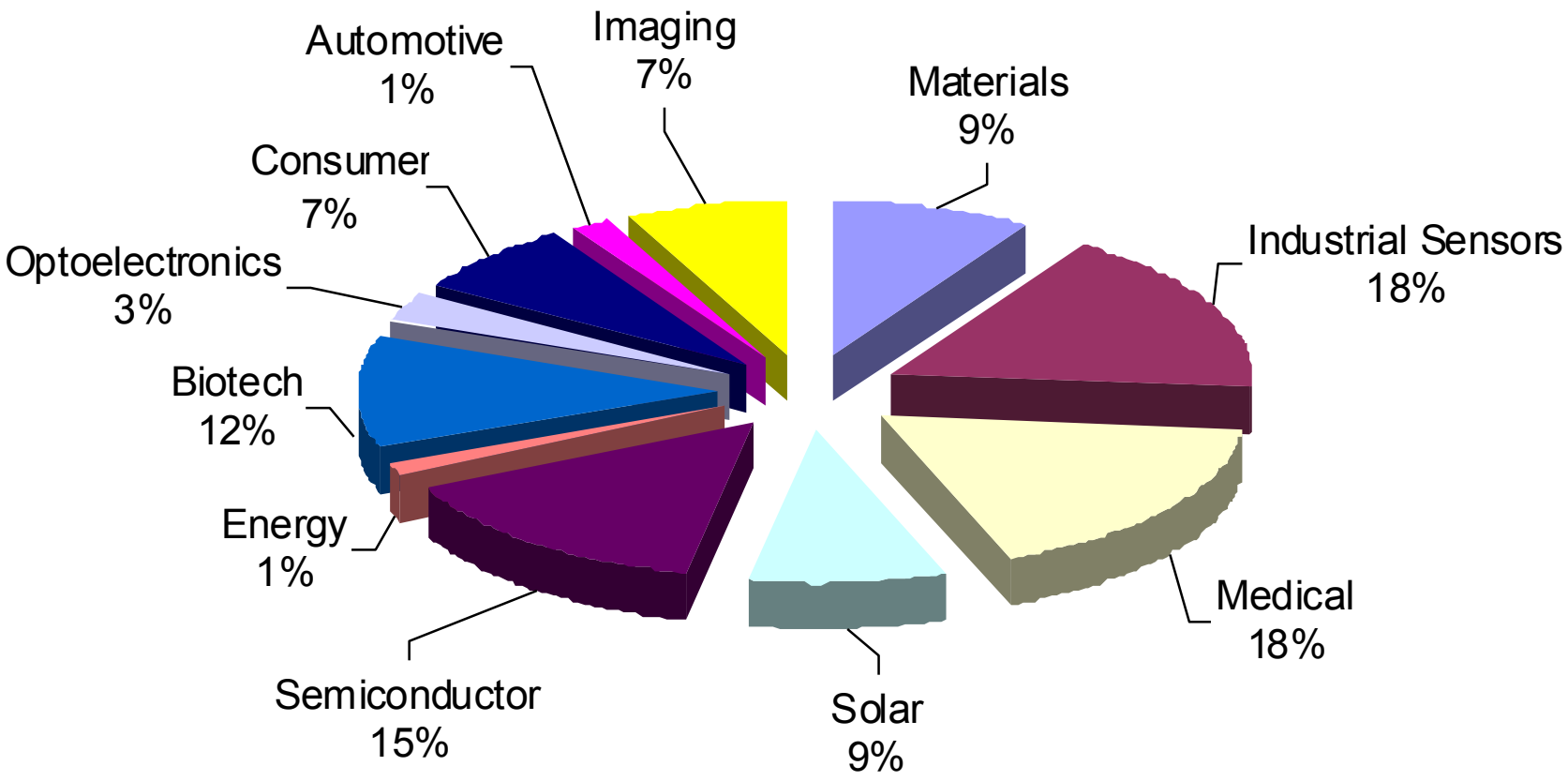

- **Multi-disciplinary engineering team**
  - **Skilled at managing development risk and uncertainty**
  - **Small batch prototype fabrication (150 mm wafers) by engineers, not operators**
  - **Design optimization using simulation**
- **Complete project management**
- **Smooth transition to production**
- **A supplier ecosystem to address all MEMS needs**

# Our Value

- **First time developing MEMS?**
  - **With our expertise and supplier ecosystem, we can provide the complete solution**
- **Improving your MEMS product?**
  - **Leverage expert analysis and deep process knowledge to optimize your design**
- **Investing in MEMS?**
  - **Valuable insight on device feasibility, robustness, and maturity from expert practitioners**
- **Our competitive advantage**
  - **In MEMS, design and process are inseparable**
  - **Our engineers are experts at both**



# Our diverse customer base



# Detailed Technical Capabilities

# MEMS design and process expertise

## Technologies we have developed:

- Piezoresistive devices
- Piezoelectric (AlN and ZnO) devices
- Electrostatic structures
- Solar cells
- Passive microfluidics
- Electrophoretic pumps
- Mold masters
- Gratings, phase shift lenses etc.
- PDMS, SU-8 structures
- Mechanical dummies for package reliability testing
- Custom test systems

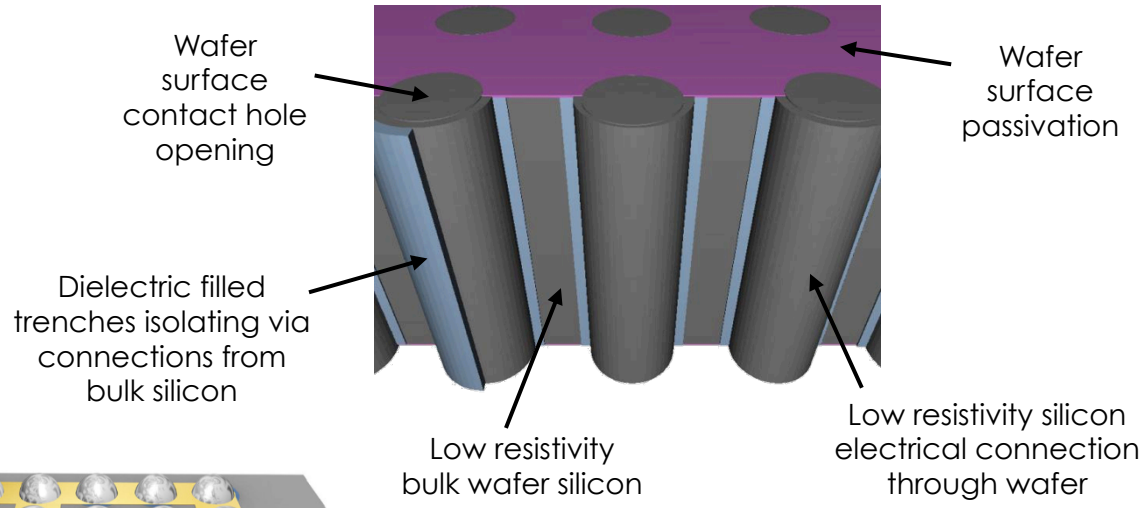
*Over 90 clients served*

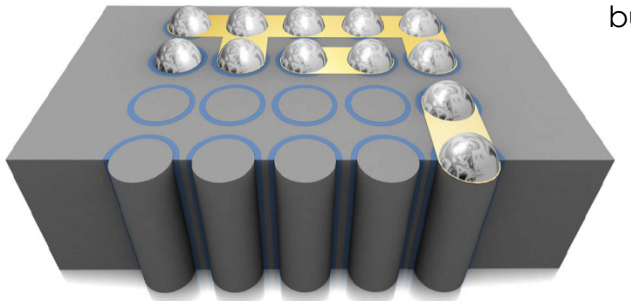
## Application areas:

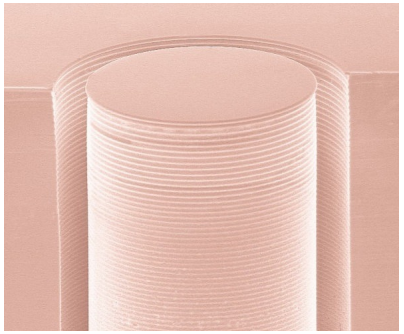
- Chemical sensing
- Materials characterization
- Medical implant
- Medical diagnostics
- Pressure sensing
- Filtration products
- Laser/ Infrared/ Visible optics
- Chip cooling
- Cell culture
- Radiation sensing
- Microphones
- Gas flow metering
- Multi-chip modules
- Solar

# Standard TSV available for prototypes

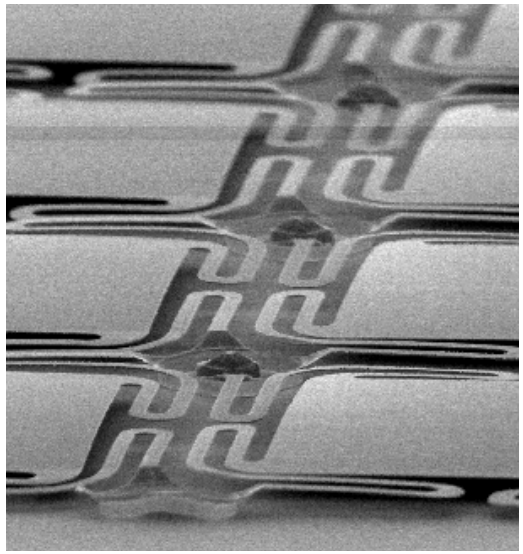
- **Silex Microsystems Sil-Via®**
  - **Already in volume production for consumer electronics**
  - **“Via-first” process**
  - **Solid via: mechanically stable and robust**



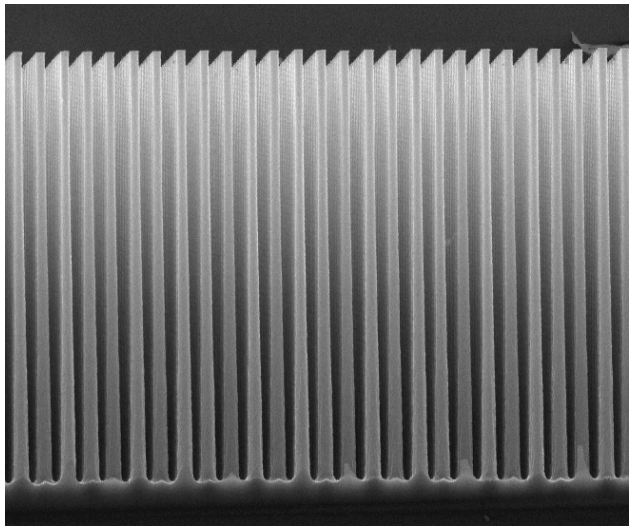


# Product development gallery: some examples

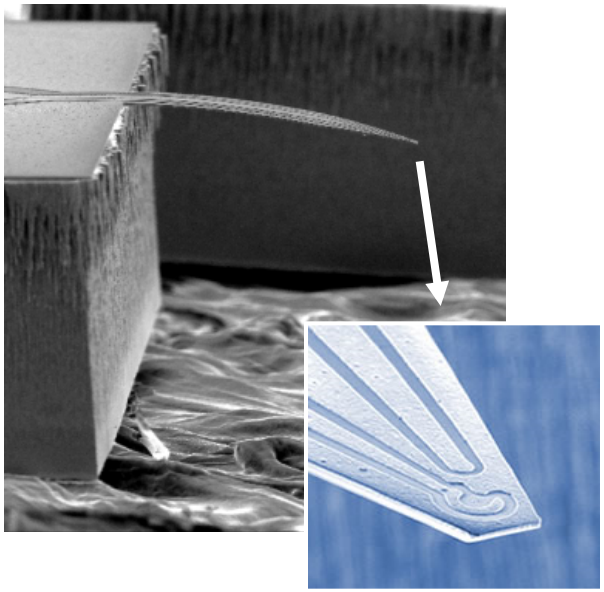


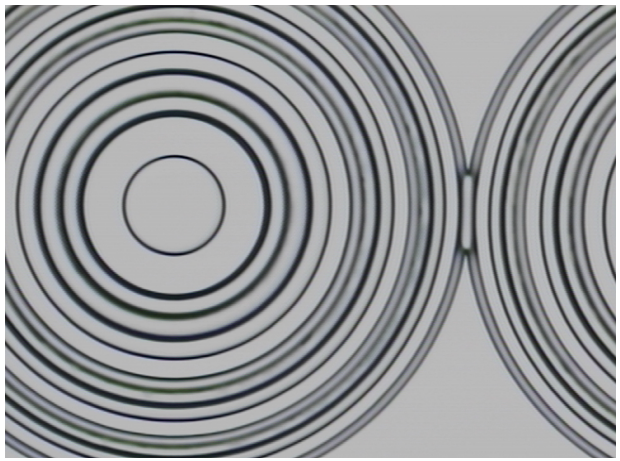
Infrared imaging pixels: MEMS over CMOS

Challenging DRIE



Customized micro-cantilevers

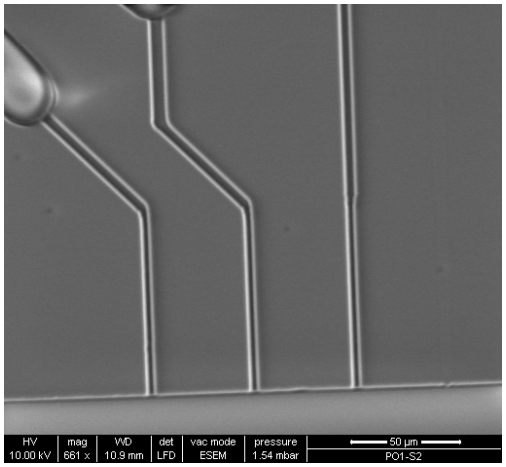


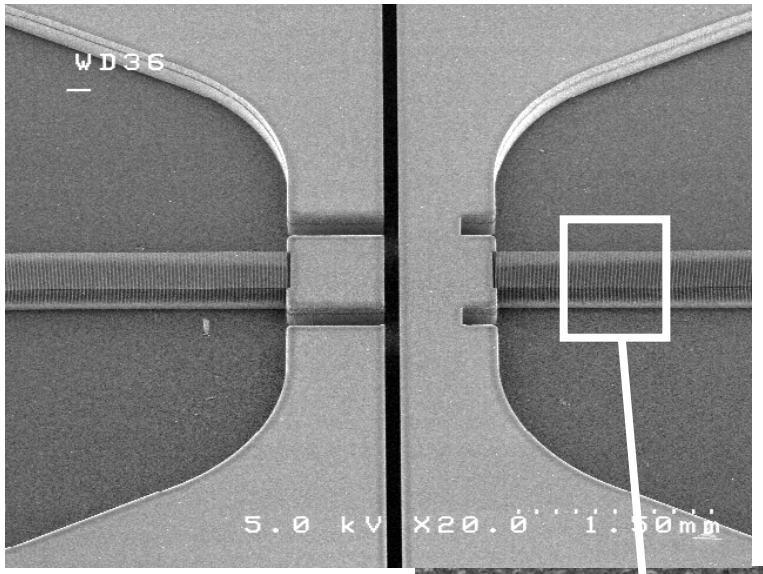


Silicon acoustic lenses

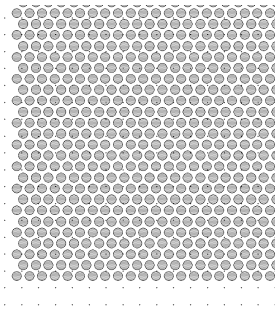
# Product development gallery: some examples

**Fluxion Biosciences:** Micro-channels for cell patch clamping

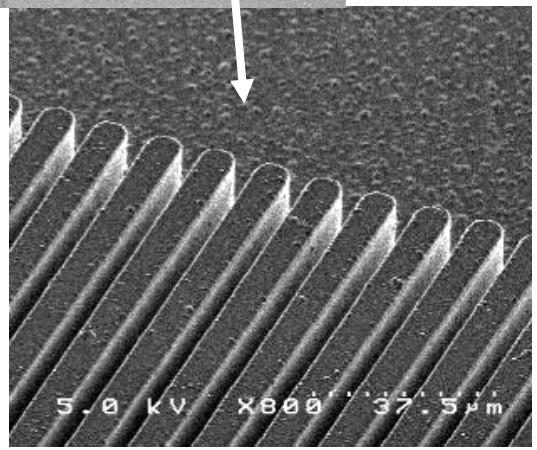


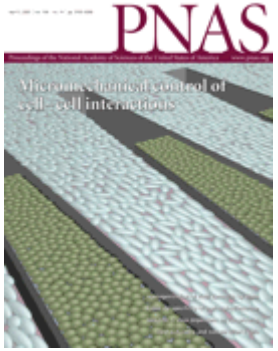

Mold masters for micro-texturing polymers



**Wave80 Biosciences:** Microfluidic chip for rapid HIV analysis



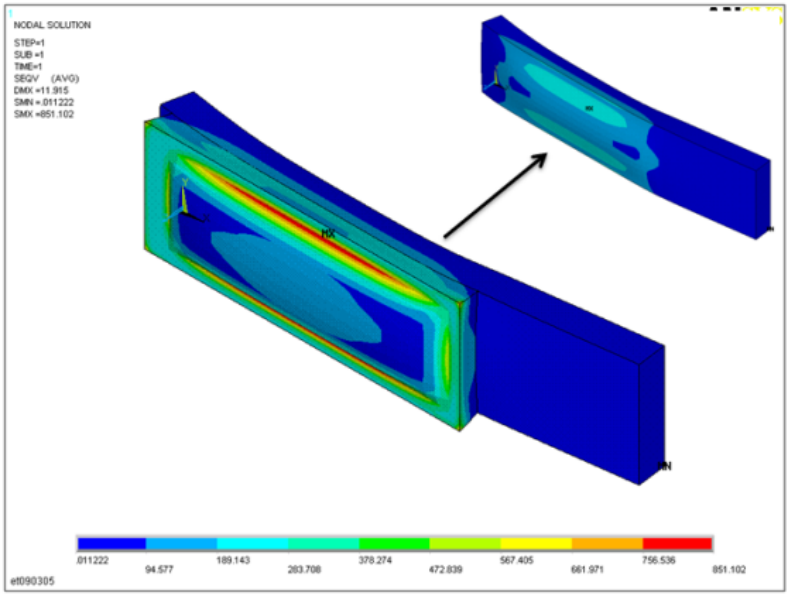

**MIT/Bhatia Lab:** cell culture platforms



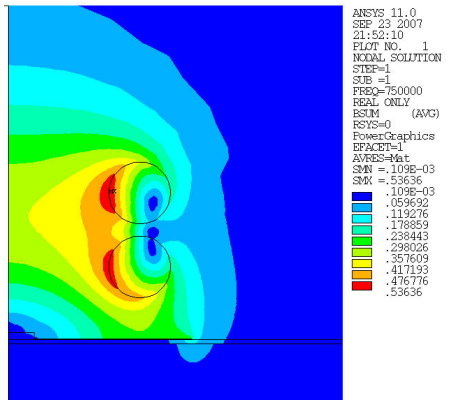
# Modeling and design optimization

- **ANSYS Multiphysics R13**
- **Matlab**
- **Proprietary fracture prediction**

- **Intelligent use of simulation to minimize risk and reduce fab cycles**
  - **Management of uncertainty in MEMS material properties**
- **Design exploration and performance optimization**




Package-induced stresses




Magnetic field of inductor coils



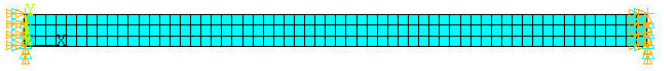


AMFITZGERALD & ASSOCIATES

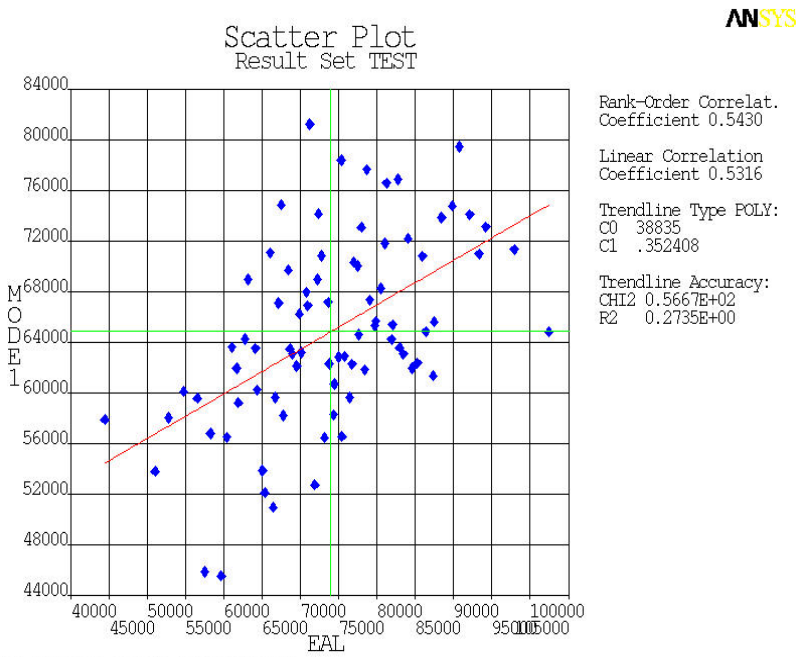
# Modeling expertise

- Basic and coupled physics interactions
- Static, harmonic, transient analyses
- Residual stress effects
- Non-linear material behavior
- Squeeze film damping
- Contact analysis
- Parameter variational analyses (“six-sigma”)
- Design for cost, performance, quality
- Multiple criteria optimization
- Development for custom pre- and postprocessors

## Example: Process variations in RF switch



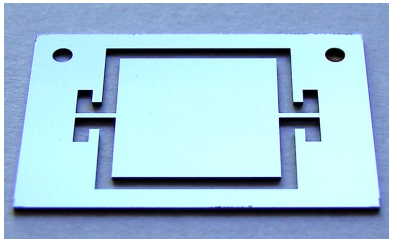
Resonant frequency vs. height, width, thickness, material property variations

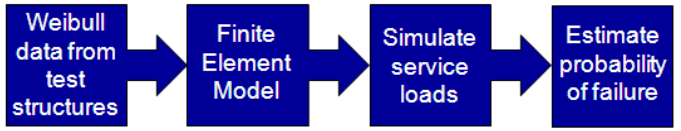


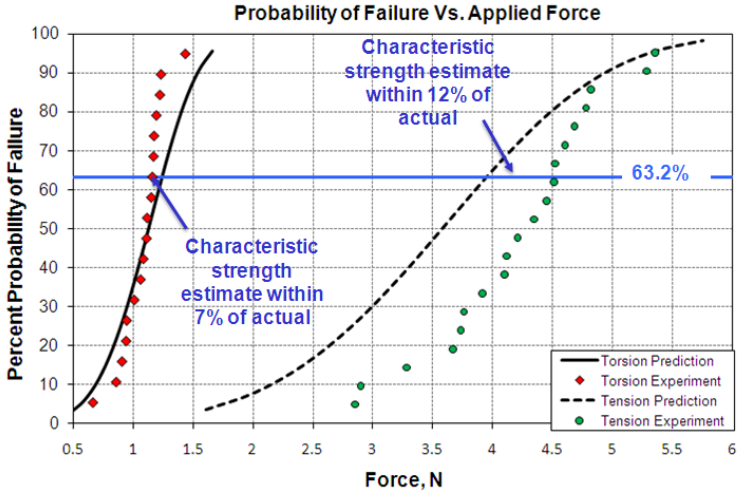
# Device reliability simulation

- Identifies where and when a device is most likely to break
- Informed design
- Reduction of time to market: fewer design, fab, test cycles required
- Process IP stays secure: fabrication and fracture of test samples is all that's needed

## Industry-leading fracture prediction

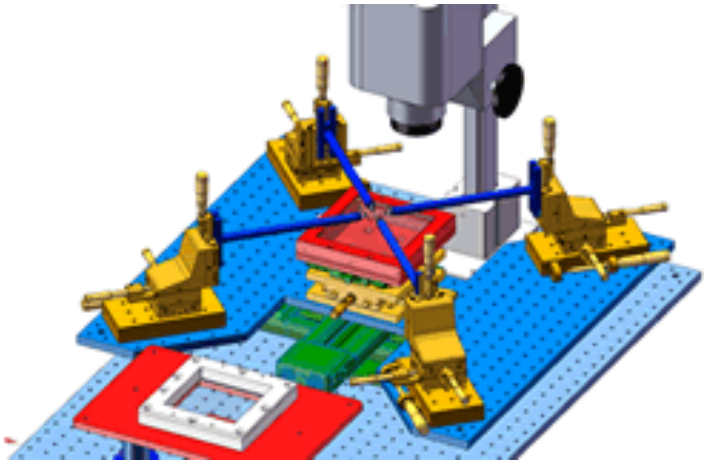




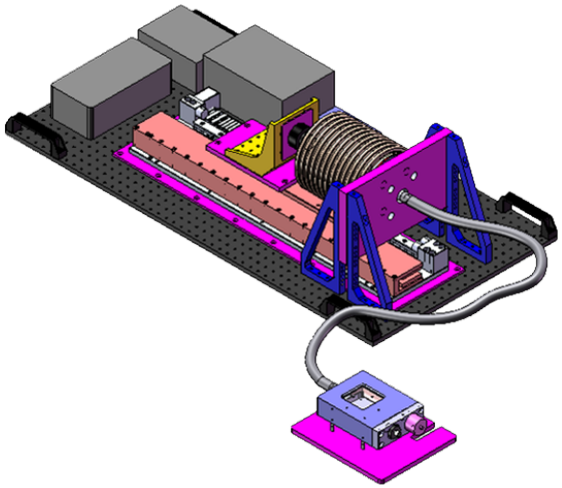



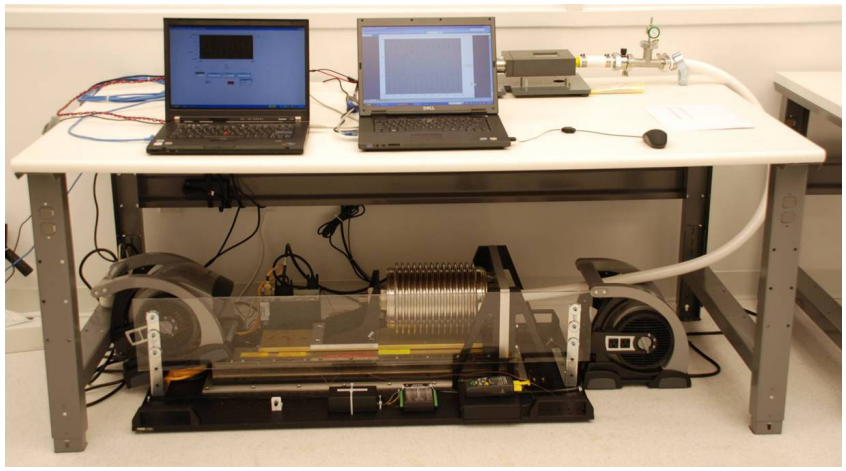
# Custom test systems

Micro-positioning stage with electrostatic chuck and stereomicroscope



Dynamic pressure test chamber





# Material testing services

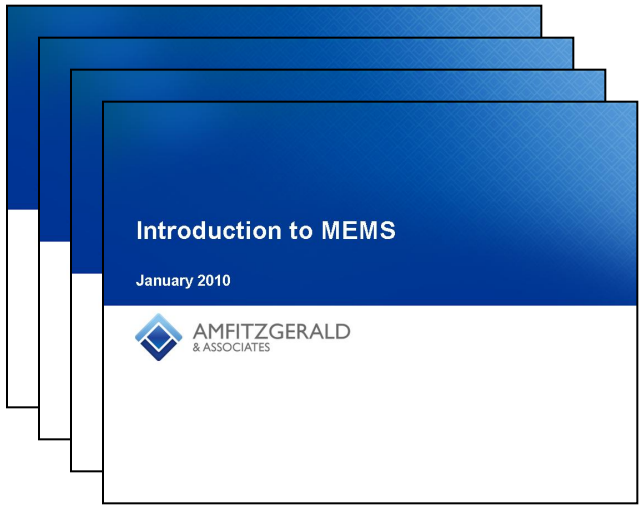
- **Material properties measurement**
  - **Test structure design**
  - **Wafer and die-level**
  - **Customization**
- **Mechanical reliability testing**
  - **Fracture**
  - **Bend**
  - **Peel**
  - **Cyclic**

We use an Instron 5942 for mechanical testing

# Technology strategy

- Device feasibility
- Manufacturing cost models
- Technology readiness
- Patent landscapes
- Development roadmaps
- Due diligence

## Customized workshops on MEMS



# Client engagements

- Initial meeting to assess fit and to discuss scope of work
- Detailed cost proposal provided, time and materials for R&D
- Project performed in discrete Phases to minimize risk
  - Phase 1: Design exploration
  - Phase 2: Prototype fabrication 1
  - Phase 3: Test and design iteration
  - Phase 4: Prototype fabrication 2
  - Etc.
- Client owns all work product and intellectual property
  - Including masks and runsheets, which will be transferred to foundries
- Full support to volume production

# The secrets to MEMS development success

- **Have adequate funds and timeline for multiple prototype iterations**
  - **A complete MEMS design is GDS data AND runsheet**
  - **MEMS processes are not standardized, so success on first run is rare**
- **Leverage standard tools and processes to the extent possible**
  - **Robust designs do not push process tolerances**
- **Bring only mature prototypes to foundry**
  - **Better pricing, faster ramp to production**
  - **Foundry is most skilled at process perfection and yield improvement**

# Public client list

## Startups and Small-Medium Businesses:

Advanced Diamond Technologies
Bay Materials LLC
Cantimer, Inc.
Edge Embossing LLC
Endotronix
Fluxion Biosciences
Hepregen
Microfabrica
Micralyne
NeuroPro Technologies
Nevada Nanotech Systems
NovaSpectra
Owens Technology
SemQuest
Silicon Light Machines
Silicon Microstructures
Solus Biosystems
SVTC Technologies
Trident  Metrology
Wave 80 Biosciences

## Public Companies:

Agilent Technologies
Applied Materials
Caliper LifeSciences
Cypress Semiconductor
Panasonic ACOM-TC
Ricoh Innovations
Sun Microsystems

## Research Institutions:

DARPA
MIT
Stanford University
Stowers Institute
UCSF, Opthalmology
University of Nevada, Reno

# Company contact information

700 Airport Blvd. Suite 210
Burlingame, CA 94010, USA
Phone: +1 (650) 347 MEMS
Fax: +1 (650) 347 6366
General Inquiries: info@amfitzgerald.com
TSV Inquiries: tsv@amfitzgerald.com


AMFITZGERALD
& ASSOCIATES