A. M. Fitzgerald & Associates, LLC
655 Skyway Rd. Suite 118 San Carlos, CA 94070 USA
+1 650.592.6100 phone +1 650.592.6111 fax
www.amfitzgerald.com

Company Capabilities

Founded in 2003, A.M. Fitzgerald & Associates provides custom research and development services to clients developing microtechnology-enabled products. We serve clients of all sizes, from startups to public companies in the Fortune 500, in three major areas:

- Micro Electro Mechanical Systems (MEMS) Product Development
- Finite Element Analysis for Reliability and Design Optimization
- Technical Strategy and Due Diligence

Our firm consists of recognized experts in MEMS development with a track record of delivering results. We are committed to providing clients with excellent technical results, creative solutions, and cost effective implementations.

A.M. Fitzgerald & Associates is a member of the MEMS Industry Group.

Expertise Domains

Micro Electro Mechanical Systems (MEMS) Prototyping

We provide comprehensive prototyping services to help clients develop their MEMS-enabled designs and to prepare for pilot production and the ramp to commercialization. From client sketches and concepts, we can flesh out designs, then develop a full mask set and runsheet, and fabricate prototypes. We can also design data acquisition systems to interact with the prototypes. When the prototype design is mature, our relationships with the major MEMS foundries enable us to quickly transfer the technology to a production facility.

Design capabilities:

- Transducer types: Piezoresistive, piezoelectric, capacitive, resonant
- Microcantilevers, with or without tips
- Microfluidics

Process capabilities:

- Mask design and layout in .TDB or .GDS format
- All bulk and surface micromachining processes for silicon, glass, and quartz, on 100 mm diameter substrates up to 10 mm thick (non-standard substrate shapes on a case-by-case basis)
- CMOS-compatible processes
- MEMS over pre-fab CMOS
- Polymer micromachining using SU-8 and PDMS
- Less common thin film materials, such as AlN, ZnO, Pt, and others
- Limited capabilities for sapphire, III-V semiconductors, and other substrates

Back-end:

- Grind and polish
- Laser coring and drilling

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- Dicing
- Wirebonding, die attach, underfill, globbing
- Chip to Flex circuit

Other processes:

- Traditional metal machining
- Rapid prototyping stereolithography
- Chemical milling of sheet metal
- Fluidic fittings

Data acquisition systems:

- Custom LabView interfaces
- Data transfer from GPIB instruments
- Wireless telemetry, including mesh networking

Finite Element Analysis (FEA) for Reliability and Design Optimization

We advocate incorporating experimental data into finite element models to improve model accuracy, since MEMS materials properties are highly dependent on process conditions. We can customize models to incorporate non-linear materials behavior data such as elastic-plastic transitions, creep, or fracture. We have particular expertise in analyzing the mechanical reliability and fracture risk of silicon and other brittle materials. Our techniques for model fine-tuning with custom data create powerful models for performance prediction. We can also help to design and execute the measurements needed to characterize material systems.

We also use FEA to perform parametric analyses to: examine sensitivity to design variables; explore the effects of process variation; evaluate design rules; develop more focused Design of Experiment fab runs. When used correctly, FEA can reduce the number of process runs required to converge and verify a new MEMS design.

We utilize the latest version of ANSYS software on high performance computers (Dual CPU, 64 bit) that can handle models up to 5 million degrees of freedom. We build all models using ANSYS's programming language, which enables us to build models faster and more accurately than those using GUI-driven software. We can also program customized element behavior. If the client has ANSYS and needs to frequently perform the same type of analysis, we can develop custom scripts for its engineers to run in-house.

Simulation capabilities:

- Multi-physics domain simulation (structural, thermal, electric, fluidic)
- Steady-state and transient responses
- Modal analyses
- Non-linear material behavior
- Squeeze film damping; Q prediction
- Contact dynamics
- Residual stresses in thin films
- Charge accumulation

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- Fracture probability
- Variational analyses and parametric design
- Probabilistic analyses
- Customized element behavior

Technical Strategy and Due Diligence

It is our business to know what is going on in the MEMS world. We keep tabs on emerging devices, process technologies, vendor capabilities, and investment trends. We provide technical opinions backed up with thorough research and data analysis.

Our process experience and active role in MEMS development makes us uniquely suited to comment on device feasibility, robustness, and maturity. We help our clients to evaluate emerging technologies from the top-level down to the last detail.

We provide answers to strategic questions such as:

- Will this technology satisfy our needs?
- Who else is working in this space and what are their technological advantages?
- What is the maturity of the technology?
- What will it take to commercialize the technology for a particular market?
- What is the IP landscape for the technology?
- What will it cost to develop and produce?

Methodologies

We begin all of our client interactions with a frank technical discussion under NDA. The goal of our initial meeting is to gain insight into the problem and to assess whether we have suitable expertise to help the client. We then work with the client to establish a statement of work for the project and a timeline, and then present a written proposal. Projects that are out of our expertise domain are referred to trusted colleagues.

We actively interact with our clients during the course of our work. We prefer to share the evolving results of our work in order to solicit the client's insights and feedback throughout the project duration. In this way, we make sure that the final finished deliverable will meet all expectations. We keep the client apprised of our progress and immediately bring attention to any problems.

Any intellectual property developed during the course of the engagement belongs to the client, including masks and runsheets. We do expect the client to recognize our contributions to any inventions or peer-reviewed research articles that result from our work.

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Case Study

Bay Materials, LLC/Cantimer Corporation

Bay Materials is in the business of developing custom polymers and materials for various medical, dental, and industrial applications. They were seeking to develop a novel MEMS sensor that leverages their polymer expertise. A.M. Fitzgerald & Associates was engaged to develop a custom MEMS chip as part of their sensor development project. We worked with the principal scientist to evolve a chip design, then developed a mask set and process flow. We fabricated the first prototypes at the Stanford Nanofabrication Facility (SNF) and worked with a vendor to package the finished die. Bay Materials used these prototype die to validate their sensing principle, perform crucial bench tests, and to iterate their overall sensor system design.

Following this, Bay Materials asked us to design and fabricate a second generation chip. Since they desired a larger quantity of chips, and the process had been stabilized, we quickly realized it would be more cost-effective to let a commercial MEMS foundry do the fabrication work. We identified the optimum foundry for the job and then worked closely with the foundry personnel to transfer our design and process flow to their tool platform.

As a result of our work, Bay Materials was able to develop a novel MEMS sensor that will be commercialized through their spinout company, Cantimer Corporation. By outsourcing the MEMS R&D to A.M. Fitzgerald & Associates, Bay Materials was able to stay focused on their core expertise, developing the polymer material that is the basis for the sensor.

Public Client List

Applied Materials
Advanced Diamond Technologies
Bay Materials LLC
Caliper LifeSciences
Cypress Semiconductor
Fluxion Biosciences
Microfabrica
Nanoconduction
NeuroPro Technologies
Nevada Nanotech Systems
Owens Technology
Panasonic ACOM-TC
Redwood Microsystems
Ricoh Innovations
Seagull Technology
Sensant Corporation
Silicon Light Machines
Silicon Microstructures
Solus Biosystems
Stanford University, Geballe Laboratory for Advanced Materials
Sun Microsystems
Trident Metrology
UCSF, Dept. of Opthalmology
University of Nevada Reno
Wave 80 Biosciences

For more information, please contact: Alissa M. Fitzgerald, Ph.D., Founder and Managing Member: amf@amfitzgerald.com, +1.650.592.6100