Inchfab: Democratized Microfabrication Internet

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The Problem

- Significant barriers exist to commercializing novel micro- and nanoscale devices which leverage semiconductor fabrication technologies
  - Standardized processes largely do not exist for novel devices (e.g. MEMS)
  - Dedicated fab facilities for R&D and production are prohibitively expensive
  - Process development cycles via foundry services can be prohibitively long

The Solution

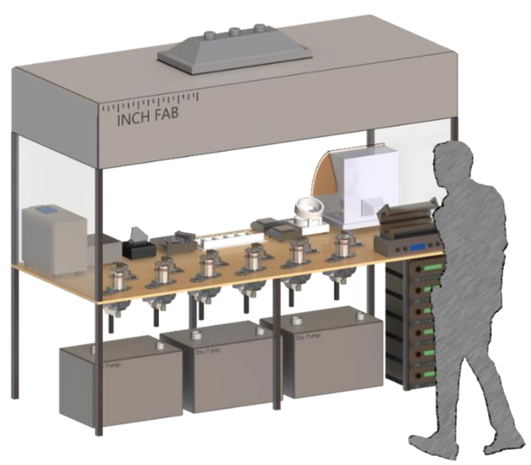
- Inchfab's solution is an integrated toolset that processes 2" substrates and cumulatively costs less than $1M
  - Incorporates modern processing techniques and performance standards
  - Provides substantially lower capital and operating costs
  - Enables local, economical device development and small-scale production

Approach

- We envision the Inchfab platform having all the tools required to produce MEMS devices initially and eventually advanced deep sub-micron devices

• Deep Reactive Ion Etching (DRIE)	• Reactive Ion Etching (RIE)
• Plasma Enhanced CVD (PEVCD)	• Low Pressure CVD (LPCVD)
• Oxidation / Diffusion / Annealing	• Physical Vapor Deposition (PVD)
• Lithography / Mask Alignment	• Wet Processing (Etch / Clean)
• Wafer Bonding (Anodic / Fusion)	• Inspection (SEM / Optical / Probe)

- Tools are designed to be inexpensive, modular, and easy to use
  - Accelerates development of new tools and processes
  - Offers path to scale up capabilities as resources expand
- A full set of Inchfab tools can be housed in a laminar flow hood for self-contained, cleanroom-grade wafer processing



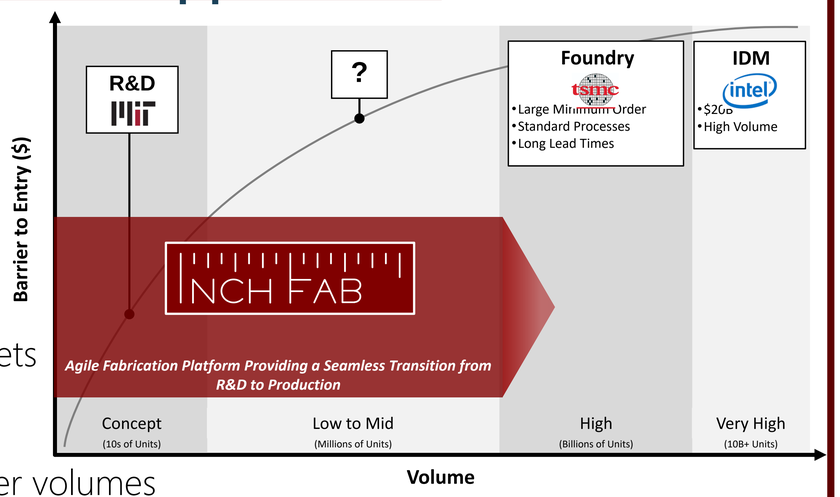
Platform Applications

Defense Applications

- High-Mix, Low-Volume
- Legacy Parts
- Die Level Packaging
- Heterogeneous integration

Market Applications

- Rapid R&D and Startups
- Low-medium volume markets
  - MEMS
- Small die size applications
  - Small die size → low wafer volumes

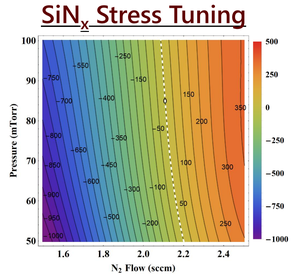


Selected Results

PECVD

- High density plasma
- SiO_2, SiN_x, and a-Si
- Uniformity: <3%
- 25-150 °C deposition temperature
- Tunable refractive index, stress, and conformality

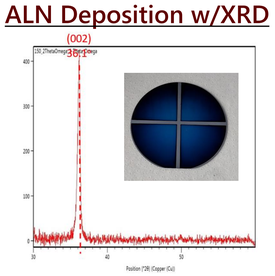
SiN_x Stress Tuning



PVD

- Magnetron sputtering
- Reactive sputtering capabilities (AlN)
- Optimized processes for metal deposition and piezoelectric materials

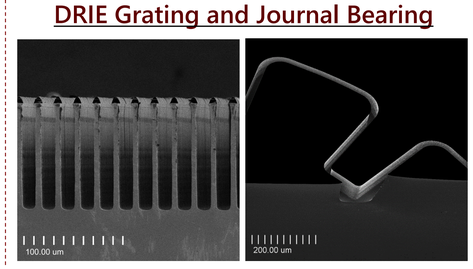
ALN Deposition w/XRD



Deep Silicon Etching

- Time-multiplexed Bosch etch process
- Etch Rate: ~6 µm/min
- Aspect Ratio: >10:1
- Uniformity: <2%
- Selectivity: >75:1 to resist

DRIE Grating and Journal Bearing



Impact

The Inchfab platform will democratize microfabrication and reenergize domestic fabrication by enabling:

- "Internet of Fabs" powered by Recipe App Store
- Secure domestic supply chains – Trusted Fabs
- Microfabrication makerspaces

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