Circuit Analysis Tools (CAT)
Developing tools that keep pace with Moore’s Law scaling

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Microelectronics designs are advancing faster than our capacity to analyze them

- When chips fail, whether due to a logic, timing or reliability issue, failure analysis determines the exact cause.
- Imaging and analysis tools isolate and identify the problem.
- Ideally the fix is proven by editing circuits on the prototype chip before any new attempts at fabrication.

CAT targets each of the five major areas of failure analysis

**Thrust 1: Circuit Edit**
Cut or create new connections

**Thrust 2: Fault Isolation**
Identify and localize defects

**Sample Preparation**
Enable nanoscale resolution

**Thrust 3: Logic Analysis**
Test logic states and timing

**Thrust 4: Fast Imaging**
Quickly image circuits

Before CAT, the best commercial tools could only image, probe, and edit chips at the 22nm node or higher

- First Time Resolved Emission (TRE) image at less than 0.5V.
- First two-photon Laser Assisted Device Alteration (LADA) with 100 nm resolution (vs. 300 nm in 2010).
- First demonstrated deposited metal at a linewidth of less than 10nm and a pitch of 15nm – 100 nm linewidth and 200nm pitch was state-of-the-art in 2010.
- First demonstration of a magnetic imaging system isolating failures in a complex 3-D interconnected package with sixteen die.
- One of the world’s first optical images of a 14 nm circuit.
- One of the first instances of reproducible, computer-controlled wafer thinning to less than 5 μm while maintaining uniform thickness.

The circuits we care about are very small...
Next generation circuits are 10000x smaller than a human hair

Timeline for Fabrication Nodes and Associated Microprocessors

- 2000
- 2010
- 2020
- 2030

Date of introduction

- 180 – 130 nm
- 90 – 65 nm
- 45 – 32 nm
- 28 – 22 nm
- 14 nm
- 7 nm
- 5 nm
- 1 nm

Transistor count

- 10,000,000
- 1,000,000
- 100,000
- 10,000
- 1,000
- 100
- 10
- 2,300

CAT leveraged the fundamental physics and chemistry of semiconductor devices to drive new tools and techniques

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