Funded by AMD, Applied Materials, ASML, Cadence, Canon, Elan, Hitachi, IBM, IME, KLA-Tencor, Magma, Marvell, Mentor Graphics, Nanobics, Panasonic, SanDisk, Spansion, Synopsys, Tokyo Electron Limited, and Xilinx, with donations from Photronics, Toppan and matching support by the U.C. Discovery Program.

**Motivation**
- The ability to predict the effect of changes in parameters during the CMP process should be expanded
- The development of robust models for CMP remains challenging
- In-situ metrology is extremely limited
- In-situ process monitoring requires:
  - Appropriate sensor types and systems
  - Interoperability

**2008 Main Objectives**
- Study sensor types suitable for in-situ monitoring, including:
  - Thermal
  - Friction
  - Acoustic emission
- Develop interoperability adapters for:
  - MTConnect
  - IPC CAMX
- Develop monitoring package

**The Problem**
- Multiple types of sensors required
  - CMP is a complex process with several parameters that can affect material removal including pressure, velocity, pH
  - No one sensor is uniquely capable of effectively monitoring all relevant process parameters nor any one process parameter across all CMP processes
- Local monitoring necessary
  - Process parameters are highly variable across a wafer surface
  - Current sensor implementation limited to global or averaged monitoring data

**Sample of In-situ CMP Sensor Technology**
- End Point Detection
- Head Zone Pressure
- Micro scratching
- Pad Condition
- YWPMU
  - Acoustic Emission ✓
  - Chemical/Electrochemical ✓
  - Friction ✓
  - MEMS ✓
  - Optical ✓
  - Thermal ✓

**AE Background**
- Acoustic emission refers to propagation of elastic waves generated by the release of energy due to external stimuli
  - Ultrasonic frequency range (~20 – 2000 kHz)

**Prior AE Research for CMP**
- Endpoint detection
- Micro-scratch detection
- Multi-sensor systems

**Current AE Research**
- Verifying and expanding endpoint detection
- Development of deterministic methodology for micro-scratch detection
- Monitoring of in-situ pad conditioning
- Expanding use of AE in multi-sensor monitoring systems

**MTConnect**
- Open-source data exchange standard for manufacturing equipment
  - Key features:
    - Based on open protocols
    - Extensible & lightweight
    - “Plug-in” architecture allows application focused development
    - Accommodates legacy & custom equipment, existing standards, & existing ex-situ metrology
    - Enables advanced process control
    - Can enable IPC CAMX on legacy equipment

**MTConnect Architecture**
- Legacy Tool (Controller)
- MTConnect-compliant tool (controller)
- MTConnect Agent

**Future Goals**
- Develop CMP monitoring software that includes ability to monitor MTConnect compliant data and to detect endpoints and faults
- Expand focus to other novel sensor technologies
- Investigate graphical mapping techniques to help achieve local monitoring