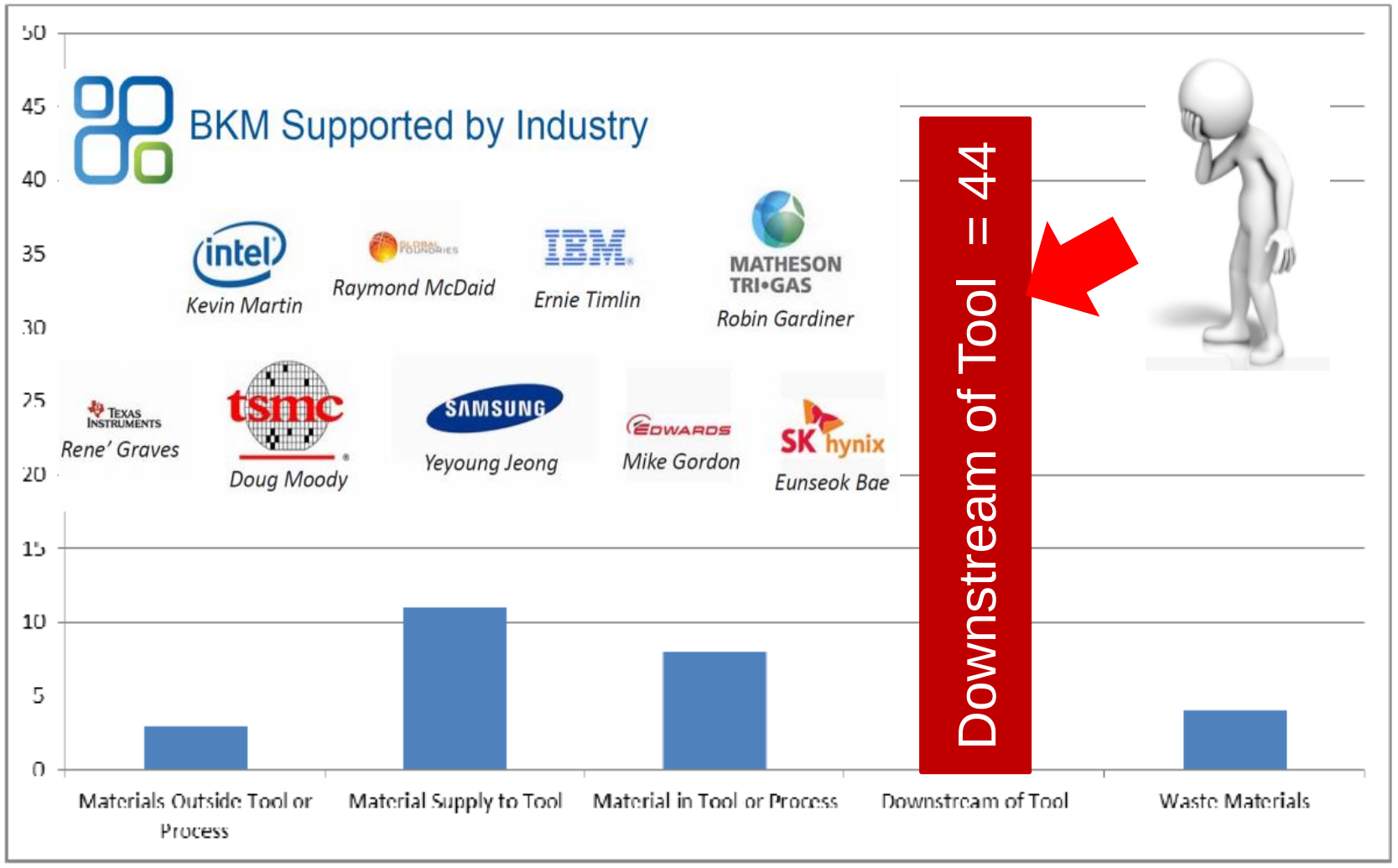
A New Safety Guideline – SEMI S30!

Energetic Materials in Semiconductor R&D and Manufacturing Processes

SESHA NE Chapter 2019
PANEL DISCUSSION

SESHA ESH for High Technology

2013 SEMATECH INDUSTRY BENCHMARKING

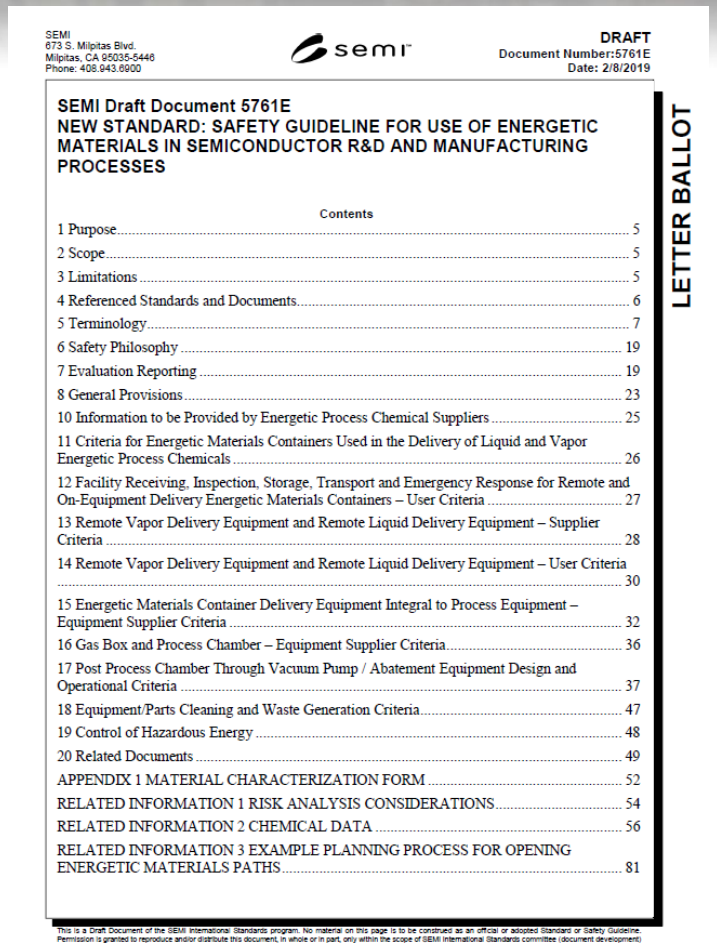


73 total "energetic" events (fires/explosions) over 3 year period

Background

- *2013 Sematech Industry Benchmarking*
  - *70+ Energetics Related Incidents in Last 3 years*
- *2013-2014 Development of BKM Document became Sematech Highest Ranked Project*
  - *Member Companies & Supply Chain Involvement*
- *2013.12 Comprehensive BKM Rev 1.0 Published by Sematech*
- *2014 BKM Introduced to SEMI Standards Development (Doc 5761)*
- *2019.4 SEMI S30 Approved by EHS Committee*
  - *5 Years & 6 Ballots*

NEW SEMI Safety Guideline (SEMI S30)



SEMI
673 S. Milpitas Blvd.
Milpitas, CA 95035-5446
Phone: 408.943.6900

semi

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LETTER BALLOT

SEMI Draft Document 5761E
NEW STANDARD: SAFETY GUIDELINE FOR USE OF ENERGETIC MATERIALS IN SEMICONDUCTOR R&D AND MANUFACTURING PROCESSES

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- ***79 Task Force Members /49 Different Companies***
  - **>50 New Definitions**
    - ***Energetic byproduct***
    - ***Hazardously Exothermic***
    - ***Pyrophoric***
    - ***Water-Reactive***
  - **1st SEMI Standard to require an "Integrated Hazard Analysis"**
  - **Covers All Lifecycles of Process**
  - **Chemical Receiving / Inspection / Transport**
  - **Chemical Distribution Systems (Gas, Liquid / Vapor)**
  - **Wafer Process Equipment**
  - **Abatement Systems**
  - **Parts Cleaning / Decommissioning**

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Evaluation Reports Challenges

Section 7: EVALUATION REPORTING

7.2 The different types of equipment to which this Safety Guideline is expected to be applied are

NOTE 11: If multiple portions of the equipment are provided by a single equipment supplier, they are responsible to provide report(s) that address all of these modules.

7.2.1 Remote Vapor Delivery Equipment and Remote Liquid Delivery Equipment

7.2.2 Process equipment

7.2.3 Vacuum Pump Equipment

7.2.4 Abatement Equipment

SEMI S2 → Applies to Wafer Processing Equipment

SEMI S30 → Applies to <u>All</u> Related Equipment

- ***Timing/Completion***
- ***Cost issues***

Fab Integration Challenges

Section 9: RISK ASSESSMENTS

9.3 *Integrated Risk assessment* — The user should ensure completion of an integrated risk assessment to identify and evaluate risks associated with the complete energetic materials path. This integrated risk assessment should be initiated as early as feasible and include appropriate representatives from the energetic process chemical supplier, material delivery equipment, process equipment, vacuum pump, and abatement equipment suppliers, and the user's staff.

NOTE 19: Integrated risk assessments are not expected to have been done at the time of assessment of separate pieces of equipment.

SEMI S30 → Collaboration…

- ***How does industry ensure this is completed?***
- ***User coordination, when, how?***
- ***Who is invited and what expertise?***

Chemical Supplier's Challenges

Section 10: INFORMATION FROM CHEMICAL SUPPLIERS

10.2 *Classifications* — A determination of "pyrophoric", "water reactive", and "hazardously exothermic" classifications in accordance with the definitions and empirical tests specified in §5 and including:

10.2.1 The objective test data and calculations on which the determinations were based. For determinations which were not based on objective data, the rationales used in making the determinations and the basis for considering the persons making the determination qualified to do so.

10.2.3 Stoichiometry and thermodynamics of reaction with water and with oxygen, including any byproducts which are flammable or otherwise hazardous

10.2.5 A video illustrating the salient properties and reaction of the energetic process chemical with air, water, and any other materials with which the energetic process chemical is foreseen to react exothermically should be provided

- the contact of material with moisture in air under controlled conditions,
- the reaction of material with water moistened cleanroom compatible absorbent wipe, and
- the contact of material with liquid water (in an inert environment if reaction with air would obscure visibility) under controlled conditions.

- ***Can this be provided when the industry needs it?***
- ***R&D Chemical Classification → Before Design?***

Chemical Supplier's Challenges

Section 10: INFORMATION FROM CHEMICAL SUPPLIERS

10.1 Energetic process chemical suppliers should provide the information described in this Section, at the time negotiated with the user.

- *User Timeline vs. Design Timeline?*
- *R&D Chemical Info Must Be Before Design ?*
  - *Equipment suppliers (process and chemical delivery) have design requirements*
- *Address IP Concerns?*

Management of Change Challenges

Section 6 - SAFETY PHILOSOPHY

6.2.5 Users maintain a management of change (MoC) program for all equipment, recipe, or chemistry changes related to energetic process chemicals or that could generate energetic byproducts for both R&D and high volume manufacturing activities. That program should include guidance on how to evaluate such changes.

MoC Requires End User to Communicate to <u>All</u> Suppliers

- ***Addressing IP concerns?***
- ***Verification MoC is in place?***
- ***Costs?***

Fab Integration Challenges

Section 8: GENERAL PROVISIONS

8.12 *Alarm Output Criteria* — Alarm outputs from safety and detection devices should be provided to allow for connection to equipment or chemical delivery shut down and the capability to interface with facility alarm systems.

8.12.1 Alarm outputs that are used as part of safety interlocks between subsystems or modules should be designed to meet the safety interlock criteria of SEMI S2 or S22 and end user documentation should specify how to connect to them.

NOTE 17: Dry contacts indicating a module ready status are a common method for addressing this.

All equipment suppliers must have safety interlocks that meet S2 and S22:

- ***Integration Between Suppliers?***
- ***Redesign Timeline & Costs?***

Chemical Supplier's Challenges

Section 11: ENERGETIC MATERIALS CONTAINERS

11.1.1.2 The risk of valve failure should be acceptable. This can be achieved by, for example, using two (one pneumatic and one manual) valves on each line or using single valves of high enough reliability and with an appropriate actuator assembly. "High enough reliability" means reliability such that the risk is acceptable.

11.1.1.4 A single hybrid valve (*i.e.*, a valve with both pneumatic and manual actuators or with a pneumatic actuator and a manual means of disabling that actuator and closing the valve) may be used, if it meets the following:

- it can be closed manually and locked whether or not there is a pneumatic signal opening the valve,
- the manual means closes the valve positively (*i.e.*, not by a spring mechanism), and
- all of the other criteria in § 11.1.1

Feasibility Challenge:

- ***Addition of 2nd Valve on Containers?***
- ***Allowance for Alternates that Don't Exist?***

Process Equipment Challenges

Section 19: CONTROL OF HAZARDOUS ENERGY

19.1.3.2 Whenever possible, the purge gas should be supplied from a dedicated source, such as nitrogen gas cylinder(s) adjacent to the energetic materials container(s).

Expansion of S18 Silane Requirements to All Energetic Materials:

- ***Costs → Equipment & Ownership?***
- ***Feasibility → Redesign Requirements?***

Process Equipment Challenges

Section 15: CONTAINER DELIVERY EQUIPMENT

15.1.2 Enclosures should be provided with self-latching, self-closing doors.

EXCEPTION: Self-closing and self-latching doors are not required if:

- the quantity of energetic material in the container(s) in the enclosure is not intended to be more than 2L,
- the energetic materials are delivered from the energetic materials container sub-atmospherically, and,
- if the container is refilled within the enclosure, a safety interlock is provided that prevents flow of the energetic material into the energetic materials container(s) and reduces the pressure in the delivery line(within the enclosure) to the energetic materials container to no more than the ambient pressure, if the equipment detects a fire, leak, or open access port door.

New Requirements to Process Equipment (Above IFC/NFPA):

- ***Purpose / Trade-Offs?***
- ***Exception Feasible?***
- ***Integration Issues?***

Process Equipment Challenges

Section 15: CONTAINER DELIVERY EQUIPMENT

15.6 *Over-temperature controls* — Over-temperature controls should be provided for heating devices. The overtemperature control's sensor, control circuit, and means of removing power should be independent of the means of temperature control used to maintain the desired temperature. Overtemperature controls should conform to the criteria for such controls included in SEMI S3.

SEMI S3 → Now Required All Equipment Suppliers

- **SEMI S3 > Previously Out of Scope**
- **Redesign, Timeline, Costs?**

Component	*Recommended Best Practice*
1. Foreline	100 mm, 316L stainless steel. Avoid horizontal sections and low points. Lagging and heating are optional. If the foreline is to be heated, the temperature should be determined based on the materials observed or foreseen to be in the foreline, but should not exceed the maximum temperature for which the equipment (e.g., o-rings) is suitable.

What about "Under-Temperature Hazard?

SUMMARY

Key Take Away's? Suggested Next Steps??

Questions??

Key Take Away's ??

Suggested Next Steps ??