

SEMI S3-91

SAFETY GUIDELINES FOR HEATED CHEMICAL BATHS

NOTICE: These guidelines do not purport to address all of the safety issues associated with their use. It is the responsibility of the users of these guidelines to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.

NOTE: As listed or revised, all documents cited shall be the latest publications of adopted standards.

1 Purpose/Scope

This safety guideline pertains to open top heated chemical baths, or “wet stations”, used in the manufacturing of semiconductors. The purpose of this guideline is to provide general safety information for the construction, operation, and maintenance of chemical baths heated by electric immersion, externally bonded or heat exchange type heating devices. This guideline is not intended to provide detailed design information for the individual components of the heating systems, but rather to supply the safety criteria for the design of these systems. (See Figure 1.)

2 Introduction

2.1 Failure to follow the manufacturer’s instructions as to the application or installation of heating systems used for chemical baths can result in accidents and fires in which such systems may be implicated.

2.2 The human element plays a major role in how well the hardware is used. The user of heated chemical bath systems needs to understand the available technology to minimize the risk involved.

2.3 The issue of bath operation and maintenance has been included in this guideline to support the safe use and maintenance of heated baths over their normal service life.

3 Heated Bath Methodology

3.1 *Electric Immersion Heaters* — Electric immersion bath heaters are resistive element heaters. The element itself is typically protected by an outer sheathing which acts as a corrosion and electrical barrier. The element is mounted to the inside of the bath.

3.2 *External Tank Heaters* — External type heaters are normally bonded by a mastic to the outside of a chemical bath. The most common types are manufactured from a thin metal foil material that results in a very low profile configuration.

3.3 *Heat Exchangers* — The most common type of heat exchanger employs a separate heating source that may be remote from the station. This heating source can be electrically powered to generate steam or some other heat transfer fluid. The heat transfer fluid is then delivered by chemically compatible plumbing to the bath and recirculated to the heater.

4 Minimum Heated Bath Safety Requirements

To ensure the safe operation and maintenance of heating systems, the following features are required.

- overcurrent protection
- power interrupt
- manual reset
- automatic temperature controller
- liquid level sensor
- overtemperature protection
- proper grounding and ground fault protection
- compatible construction materials

NOTE: Interlocks should operate as outlined in SEMI S2. These features should be totally compatible with each other.

4.1 *Overcurrent Protection* — A fused disconnect switch or circuit breaker sized for the amperage of the heater.

4.2 *Power Interrupt* — In the event of an overtemperature, low liquid level, or ground fault condition, power to the heater(s) is interrupted upon receiving the respective signal. The interrupt should be separate from any relay incorporated into the automatic temperature controller. The interrupt should be wired in such a manner that any signal from the liquid level sensor, overtemperature sensor, or ground fault condition should shut off power to the heaters and place the system in a “fail safe” condition.

4.3 *Manual Reset* — This reset should be incorporated into the power interrupt device so that when the system shuts off power to the heating element, a manual reset is required to re-energize the system.

4.4 *Automatic Temperature Controller* — An automatic temperature controller maintains the liquid at a set temperature by turning the heating element on and off. The controller is activated by signals from a sensor that is located at the bath. To preserve the integrity of this system, quarterly service/testing and calibration in

accordance with the manufacturer's recommendations should be performed.

4.5 Liquid Level Sensor — This sensor will act to shut down the heating element if the liquid level falls below a safe operating level. When employing either an immersion or externally mounted type heater, it is recommended that this level be no less than five centimeters (two inches) above the heating element's "hot zone" as established by the manufacturer. This should prevent the element from losing the heat sink created by the liquid.

4.5.1 The selection of a suitable sensor should take into account:

4.5.1.1 The physical properties of the liquids being heated and the environmental conditions to which the sensor(s) will be subjected.

4.5.1.2 The mode of failure, if the sensor fails.

4.5.2 To preserve the integrity of these components, they should be tested on a quarterly basis and serviced following the manufacturer's recommendations.

4.6 Overtemperature Protection

4.6.1 Liquid Overtemperature — A dedicated liquid overtemperature sensor should typically be set to trip at a temperature below the autoignition temperature of the chemical being used in the bath, and in no case higher than 10°C (18°F) above the normal operating temperature.

4.6.1.1 This temperature setting should compensate for the initial over-shoot often encountered when bringing the liquid from ambient to operating temperature.

4.6.1.2 The sensor should be located in the liquid at an elevation approximating the top of the heating elements "hot zone" and no more than seven centimeters (three inches) away from the heater.

4.6.2 Heating Element Overtemperature — When using an electrical immersion type heater, a sensor should be used to shut down the heating element if the surface temperature of the element exceeds a preset value. The sensor is typically placed between the resistance coil and the protective sheath covering.

4.7 Proper Grounding & Ground Fault Protection — The amount of insulation surrounding a heater element depends upon the type of heater. This insulation not only provides protection from the corrosive properties of the solution, but also acts as an electrical barrier. If the barrier breaks down, it is possible for the solution to become energized.

4.7.1 The electric heater elements should be equipped with a ground, the construction of which should be

approved by a nationally recognized testing laboratory (NRTL).

4.7.2 A ground fault circuit interrupter (GFCI) should be used to preclude worker exposures to potential electrical shock.

4.7.3 The station or equipment in which the heated bath will be used needs to be reviewed to ensure that all National Electrical Code requirements have been addressed.

4.8 Compatible Construction Materials — All portions of the station that could come in contact with process chemicals should be constructed from materials compatible with these chemicals. It is recommended that metal materials be used in the station's construction when using combustible or flammable solutions.

5 Operation and Maintenance

5.1 Before heated baths are put into service, a detailed review of the wet station operation and maintenance should be conducted for all employees operating or servicing the station. New employees should receive the same information prior to work assignment.

5.1.1 All safety features included with the station's heating system should be user tested, and the frequency of testing should be noted in the user's periodic maintenance procedures.

NOTE: Recommended minimum frequency of testing is quarterly and after any station maintenance.

5.1.2 Vendor-supplied information on the bath operation and limitations that may apply should be reviewed and appropriate employee training conducted.

5.1.3 When the user plans to install the baths and to perform maintenance, the suppliers should provide guidance to ensure that all aspects of the system, such as the controller and the heated bath safety systems, are integrated properly.

5.1.4 Review the process requirements to ensure that operating temperatures are within the range and capability of the safety controls. For flammable and combustible liquids, operating temperatures should be below the ignition temperature.

5.1.5 Limit the interchanging of parts that were not included in the original design unless so advised by the supplier. Alternate parts can lead to failures resulting in a fire or physical injury.

6 Related Documents

6.1 UFC 1988 edition.

6.2 OSHA Safety & Health Standards (29 CFR 1910).