DOWNLOAD PDF SEMICONDUCTOR EVALUATION TECHNIQUES

Chapter 1 : Technical Documentation | ON Semiconductor

A transient thermal technique is used to test the difference in the crystalline structure of silicon wafer and silicon polycrystal. Short duration joule heat pulse (3.

This paper highlights key industrial hygiene monitoring strategies for selected normal production operations and maintenance tasks. Monitoring for airborne and surface chemicals, ionizing radiation, radiofrequency and microwave radiation, ultraviolet and infrared light, static magnetic fields, and ventilation effectiveness is discussed. Areas of traditional industrial hygiene focus, such as photolithography, are addressed, with an emphasis on best available assessment approaches. Specific exposure issues are presented, such as cyanide compounds in metal etch chamber residues and arsenic surface contamination from ion implanter parts, with a discussion of commonly reported monitoring results. Introduction The art and science of industrial hygiene involves the recognition, evaluation, and control of workplace hazards. At first glance, the typical semiconductor fabrication facility fab appears to be a pristine, clean environment. Great care is taken to ensure ambient air purity, with newer processing tools isolated in mini-environments to minimize potential product contamination. Fab employees appear well protected in uniformly white head-to-toe garments. The fab itself is quiet relative to a typical heavy manufacturing environment, and production employees are rarely exposed to extreme safety conditions. So the new industrial hygienist gowns up once, wanders around, becomes entranced by the coaters for a while, and leaves thinking all is well and she better get back to that flickering computer monitor problem near the electrical panelâ€¦ Scratching the surface a bit, a more complex world unfolds. The typical fab presents a variety of chemical and radiation hazards, many of which are unique to the semiconductor industry. In many cases, these hazards are well recognized before the equipment is installed. The processing tools use an array of toxic gases, solvents, and metals during normal production. Maintenance activities may introduce additional chemicals, and often create opportunities for employee exposure that do not exist during normal production. This paper reviews hazard evaluation techniques for the semiconductor facility, then presents examples of some specific exposure situations. Industrial Hygiene Evaluation Before conducting any field monitoring, the industrial hygienist must create an evaluation strategy. Instead of classifying employees into similar exposure groups only by job classification, it is especially important in the fab environment to assess exposures by task. Such a strategy should include information on the tasks conducted, tools and equipment used, associated hazards, and controls in place. Each item on the strategy should be prioritized, and the monitoring plan designed to capture the high priority tasks first. In reality, industrial hygiene monitoring is often strongly focused on employee concerns and odor complaints, in addition to the prioritized tasks. Industrial hygiene monitoring in the fab typically includes some or all of the following equipment: This will almost always include evaluation of wet bench face velocity, which is quite different from laboratory fume hood face velocity evaluation. The tools required include a thermal anemometer or velometer, a tape measure, and a vapor visualization device. In this environment, the tool enclosures minimize chemical and radiation exposures to the fab operators. Some direct chemical exposures may still exist, as when using open chemical baths or performing routine cleaning steps, but these exposures are usually of short duration. Radiation exposures would typically only result during normal production from tool leakage due to inadequate tool maintenance. Photolithography One frequent area of odor generation, and resulting employee concern, is photolithography. Newer photolithography equipment is designed to keep contaminants out of the process, which conveniently keeps odors in. Many facilities, though, are still plagued by recurring nuisance solvent odors. Because of the toxic nature of photoresist solvents previously used in the industry, media attention, and the relative lack of odors in other areas of the fab, among other factors, this area frequently induces employee concerns and, therefore, ends up near the top of the industrial hygiene priorities list. Photolithography solvents can be monitored in a variety of ways, from traditional air sampling pumps and media to portable gas chromatography units ref. Gas chromatography has low enough detection limits to record background solvent concentrations in the ppb range. These detection limits are required to detect and track concentrations of chemicals with low odor thresholds, such as those present in photolithography areas.

Wet Chemistry Wet benches containing either solvent or acid chemistry are prevalent throughout most facilities, presenting some of the most common direct chemical exposures to fab operators. The primary exposure controls are covers on the chemical baths themselves and ventilation. In order to assess airborne exposure, air sampling pumps can be used to collect both personal and area samples. In addition to chemical monitoring, the effectiveness of the ventilation system should be periodically checked. Wet bench local exhaust ventilation functions differently from a traditional laboratory-type fume hood. The typical wet bench design uses the room laminar flow to increase capture efficiency at the chemical baths. This standard can be used as a guideline, but should be supplemented with qualitative capture efficiency data such as that obtained with a vapor visualization device. Radiation Monitoring If equipment is well maintained, it is unusual for fab operators to be exposed to any type of radiation during normal production. Ion implanters are periodically surveyed, by running the survey meters along all surfaces of the tool, to ensure that no ionizing radiation leakage is present. Plasma tools are periodically surveyed for Rf or MW radiation to ensure that no leakage is present at the back of the tool many instances of Rf leakage result from missing screws in the matching network or other parts of the tool directly exposed to Rf. As long as the viewports have UV shielding, exposures are unlikely. IR radiation may also be present at horizontal diffusion furnaces. Finally, any tool with a static magnet should be surveyed to determine the extent of the magnetic field, so that hazard alerts can be posted for pacemaker wearers. Maintenance Tasks Maintenance tasks, particularly those that require opening enclosures or tools, can lead to employee exposures not present during normal operation. The loss of ventilation and the influx of room air create chemical exposures for maintenance personnel ref. Maintenance exposures may arise during routine preventative maintenance and during trouble shooting. Chamber Cleans Etch and deposition chamber tools are at the forefront of maintenance exposures. The chemicals used in these tools often leave highly corrosive residues of fluoride or chloride compounds. Because of the nature of plasma processing, the residues left in these chambers are of unknown chemical composition, so the industrial hygienist needs to do some predictive chemistry, look at previous monitoring reports, and use professional judgement in the hazard recognition stage of sampling strategy development. For example, over the past year or so, several reports of cyanide and cyanogen compound presence in the air during manual metal etch wet chamber cleans have been reported ref. Pais, SSA proceedings. While integrated personal air samples are almost always non-detectable for most potential process by-products, area samples located in a worst-case position and direct-reading measurements have shown halogen HF, HCl and cyanide compound HCN, CNCl concentrations above the American Conference of Governmental Industrial Hygienists ACGIH exposure limits. This is significant in that the exposure limits for these four compounds are all Ceiling values, which should not be exceeded during any part of the work day. Ion Implanter Tasks Ion implanters use materials such as arsenic, arsine gas, boron, boron trifluoride, and antimony in semiconductor wafer processing. Exposure to arsenic, a carcinogen, is a particular concern during maintenance activities. Some activities, such as source chamber cleaning, present significant arsenic exposure to maintenance technicians. Other activities, such as source removal or parts cleaning, may present lesser exposures. In most cases, arsenic surface contamination is a concern ref: Roberge, SSA proceedings. Conclusion Industrial hygiene monitoring provides a means to evaluate potential hazards to human health in the semiconductor manufacturing environment. The monitoring techniques available continue to evolve, as with portable gas chromatography, and decreasing chemical detection limits. Even with state-of-the-art monitoring equipment, the industrial hygienist must use professional judgment in evaluating results and making recommendations, particularly when multiple monitoring techniques are used. As new semiconductor processes are introduced, industrial hygiene techniques can be used to help identify potential hazards before introduction of the process to the manufacturing environment, in addition to monitoring in the production fab.

DOWNLOAD PDF SEMICONDUCTOR EVALUATION TECHNIQUES

Chapter 2 : Semiconductors | Plexim

Therefore it is necessary and important to do the process risk assessment of semiconductor manufacturing techniques. semiconductor. The technique is based on two.

You have questions on this product or you need more information? The high density of functional integration of microsystems e. As a result of increasing integration or the necessary structural design for converting physical magnitudes into electrical ones the structures to be measured no longer lie on the same level. This makes the CD determination by means of optical measuring methods more difficult and the definition of the actual width of the structure a challenge. The confocal measurement by the WaferInspect measurement system captures the design of the 3D structure in its entirety so that it can be analyzed extensively. The user has the advantage of a robust measuring technique and in this case, in particular, the use of non-polarized light, which makes measurements of most different combinations of material possible. In addition, the wavelength of the light nm, green prevents the exposure of photoresist and is also of advantage for the analysis of transparent materials. As a result of the above-mentioned benefits, latest process technologies can be measured reliably also in series production mode. The procedure is as simple as you can imagine. At first, the user picks and teaches a series wafer. Next, the positions for the fine alignment of the wafer are set. Any alignment mark can be used. Besides, it is possible to align wafers that do not contain structures, for example, render them usable also with KLA files. When the alignment is complete and the coordinates transformed by the measurement system, the layout of the wafer is taught or loaded. Different layout formats are supported, e. If no layout file is available, the DIE pitch is taught. For that, the diagonals of the DIEs are measured in 3 steps. The taught layout is now used for simple navigation and recipe generation. The principle is the same for all measurement tasks that can be realized with the WAFERnspect system. Furthermore, selected DIEs can be saved and loaded and a list on coordinates loaded for measurement. The use of measuring recipes makes all other measurements automatic procedures without operator intervention. The different steps are executed automatically by the measurement system and at the end the measuring values are saved and may be transferred to the host system, if required. Finally, the results are displayed on the wafer layout and shown red and green as permitted by the limit values.

Chapter 3 : ON Semiconductor

New Semiconductor Device Evaluation System for Failure Analysis of Sub-nanometer Areas is approximately to nm. These techniques are.

These detectors were somewhat troublesome, however, requiring the operator to move a small tungsten filament the whisker around the surface of a galena lead sulfide or carborundum silicon carbide crystal until it suddenly started working. At the time their operation was completely mysterious. Metal rectifier Another early type of semiconductor device is the metal rectifier in which the semiconductor is copper oxide or selenium. Westinghouse Electric was a major manufacturer of these rectifiers. World War II[edit] During World War II, radar research quickly pushed radar receivers to operate at ever higher frequencies and the traditional tube based radio receivers no longer worked well. The introduction of the cavity magnetron from Britain to the United States in during the Tizard Mission resulted in a pressing need for a practical high-frequency amplifier. By this point they had not been in use for a number of years, and no one at the labs had one. After hunting one down at a used radio store in Manhattan , he found that it worked much better than tube-based systems. He spent most of trying to grow more pure versions of the crystals. He soon found that with higher quality crystals their finicky behaviour went away, but so did their ability to operate as a radio detector. One day he found one of his purest crystals nevertheless worked well, and it had a clearly visible crack near the middle. However as he moved about the room trying to test it, the detector would mysteriously work, and then stop again. After some study he found that the behaviour was controlled by the light in the roomâ€”more light caused more conductance in the crystal. He invited several other people to see this crystal, and Walter Brattain immediately realized there was some sort of junction at the crack. Further research cleared up the remaining mystery. The crystal had cracked because either side contained very slightly different amounts of the impurities Ohl could not removeâ€”about 0. One side of the crystal had impurities that added extra electrons the carriers of electric current and made it a "conductor". The other had impurities that wanted to bind to these electrons, making it what he called an "insulator". Because the two parts of the crystal were in contact with each other, the electrons could be pushed out of the conductive side which had extra electrons soon to be known as the emitter and replaced by new ones being provided from a battery, for instance where they would flow into the insulating portion and be collected by the whisker filament named the collector. However, when the voltage was reversed the electrons being pushed into the collector would quickly fill up the "holes" the electron-needy impurities , and conduction would stop almost instantly. This junction of the two crystals or parts of one crystal created a solid-state diode, and the concept soon became known as semiconduction. The mechanism of action when the diode is off has to do with the separation of charge carriers around the junction. This is called a " depletion region ". Development of the diode[edit] Armed with the knowledge of how these new diodes worked, a vigorous effort began to learn how to build them on demand. Within a year germanium production had been perfected to the point where military-grade diodes were being used in most radar sets. Development of the transistor[edit] Main article: History of the transistor After the war, William Shockley decided to attempt the building of a triode -like semiconductor device. He secured funding and lab space, and went to work on the problem with Brattain and John Bardeen. The key to the development of the transistor was the further understanding of the process of the electron mobility in a semiconductor. It was realized that if there were some way to control the flow of the electrons from the emitter to the collector of this newly discovered diode, an amplifier could be built. For instance, if contacts are placed on both sides of a single type of crystal, current will not flow between them through the crystal. However if a third contact could then "inject" electrons or holes into the material, current would flow. Actually doing this appeared to be very difficult. If the crystal were of any reasonable size, the number of electrons or holes required to be injected would have to be very large, making it less than useful as an amplifier because it would require a large injection current to start with. That said, the whole idea of the crystal diode was that the crystal itself could provide the electrons over a very small distance, the depletion region. The key appeared to be to place the input and output contacts very close together on the surface of the crystal on either side of this region. Brattain started working on building such a device, and tantalizing hints of amplification continued to appear as the team worked on the problem. Sometimes the system would work but then stop working unexpectedly. In one instance a non-working system started working when placed in water. Ohl and Brattain eventually developed a new branch of quantum mechanics , which became known as surface physics , to account for the behaviour. The electrons in any one piece of the crystal would migrate about due to nearby charges. Electrons in the emitters, or the "holes" in the collectors, would cluster at the surface of the crystal where they could find their opposite charge "floating around" in the air or water. Yet they could be pushed away from the surface with the application of a small amount of charge from any other location on the crystal. Instead of needing a large supply of injected electrons, a very small number in the right place on the crystal would accomplish the same thing. Their understanding solved the problem of needing a very small control area to some degree. Instead of needing two separate semiconductors connected by a common, but tiny, region, a single larger surface would serve. The electron-emitting and collecting leads would both be placed very close together on the top, with the control lead placed on the base of the crystal. When current flowed through this "base" lead, the electrons or holes would be pushed out, across the block of semiconductor, and collect on the far surface. As long as the emitter and collector were very close together, this should allow enough electrons or holes between them to allow conduction to start. The first transistor[edit] A stylized replica of the first transistor The Bell team made many attempts to build such a system with various tools, but generally failed. Eventually they had a practical breakthrough. A piece of gold foil was glued to the edge of a plastic wedge, and then the foil was sliced with a razor at the tip of the triangle. The result was two very closely spaced contacts of gold. When the wedge was pushed down onto the surface of a crystal and voltage applied to the other side on the base of the crystal , current started to flow from one contact to the other as the base voltage pushed the electrons away from the base towards the other side near the contacts. The point-contact transistor had been invented. What is now known as the " pâ€”nâ€”p point-contact germanium transistor " operated as a speech amplifier with a power gain of 18 in that trial. Origin of the term "transistor"[edit] Bell Telephone Laboratories needed a generic name for their new invention: Pierce , won an internal ballot. This is an abbreviated combination of the words "transconductance" or "transfer", and "varistor". The device logically belongs in the varistor family, and has the transconductance or transfer impedance of a device having gain, so that this combination is descriptive. Improvements in transistor design[edit] Shockley was upset about the device being credited to Brattain and Bardeen, who he felt had built it "behind his back" to take the glory. Shockley was incensed, and decided to demonstrate who was the real brains of the operation. This structure went on to be used for the vast majority of all transistors into the s, and evolved into the bipolar junction transistor. With the fragility problems solved, a remaining problem was purity. Making germanium of the required purity was proving to be a serious problem, and limited the yield of transistors that actually worked from a given batch of material. Scientists theorized that silicon would be easier to fabricate, but few investigated this possibility. Teal was the first to develop a working silicon transistor, and his company, the nascent Texas Instruments , profited from its technological edge. From the late s most transistors were silicon-based. Within a few years transistor-based products, most notably easily portable radios, were appearing on the market. The static induction transistor , the first high frequency transistor, was invented by Japanese engineers Jun-ichi Nishizawa and Y.

Chapter 4 : Capacitanceâ€“voltage profiling - Wikipedia

Chapter 3 Semiconductor Device Failure Analysis Evaluation of Electrical Characteristics techniques and methods.

Chapter 5 : Semiconductor device - Wikipedia

Analysis of Semiconductor Structures by Nuclear and Electrical Techniques the work at Caltech has concentrated on evaluation of # Semiconductors.