METHODS TO PREVENT METAL DEPOSITED WAFERS FROM CONTAMINATING THE FRONT-END CLEANING SINKS OR FRONT END FURNACES

BACKGROUNG OF THE INVENTION

(1) Field of the Invention

The invention relates to the field of semiconductor wafer manufacturing, and more specifically to methods of preventing partially processed wafers that have to be reworked from contamination front-end operations of the manufacturing line.

(2) Description of the Prior Art

Semiconductor wafer processing typically is a complex process including a large number and variety of processing steps. These processing steps are, during each of the sequences that are executed as part of the step, closely monitored and may result in a complex web of rework, rejects, partial rework, etc. This leads not to the ideal processing sequence where a wafer proceeds from known step to known step but can result in many diverse flows of partially completed wafers. Wafers may be returned to prior processing steps causing concerns of wafers further down the processing line

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being contaminated with wafers that have already undergone more advanced steps of processing. It is therefore important to screen for such occurrences and to limit or eliminate the impact of contamination that may be introduced into a wafer processing operation by wafers that are not part of the regular wafer processing flow.

During normal wafer processing, meticulous attention is paid to obtaining and maintaining a clean and particle free environment. This clean environment has a direct impact on wafer yield and therefore on wafer cost. Wafer processing by its very nature tends to introduce impurities into the processing environment, these impurities can for instance be introduced from wafer processing furnaces. Dependent on the type of particle, these particles may diffuse into the semiconductor substrate, especially in areas of the manufacturing process where high frequency operations are being performed on the substrate. This can have a severe detrimental effect on wafer properties making these wafers unsuitable for further use. In other cases, donor or acceptor dopants may be introduced to substrates. These dopants can have a direct affect on the performance of the devices that are at a later stage to be created from these wafers. Yet other impurities can cause surface defects in the surface of

the wafer or stacking faults or dislocations in the atomic structure of the substrate. Poor wafer surface can be caused by organic matter that is present in the wafer-processing environment, such as oil or oil related matter.

All of these impurities must be carefully monitored and controlled and must, when present, be removed from the wafer processing environment. This control must be exercised within the cycle of wafer processing steps and at the beginning of the wafer processing process. The frequency and intensity of such contaminant control operations is highly cost dependent and should, wherever possible, be performed at as low a cost as can be accomplished. These methods of identification and elimination must therefore be simple but yet effective.

To start wafer processing with wafers that are free of contaminants, loose particles are typically first removed from the wafers by means of a wafer scrubbing process. In this way various dusts (atmospheric, silicon and quartz), photoresist chunks and bacteria are removed. Where very small particles are to be removed this is usually accomplished by a polishing operation.

Organic impurities such as hydrocarbons and greases are, after the cleaning process, removed with the use of solvents such as trichloroethylene, acetone, p-xylene, methanol and ethanol. A final cleaning can then be performed using various inorganic chemicals to remove heavy metals, for example. These inorganic chemical mixtures are strong oxidants, which form a thin oxide layer at the wafer surface. This oxide layer is stripped, removing impurities absorbed into the oxide layer.

Also used to further enhance wafer cleaning can be conventional chemical cleaning operations that include acid and rinse baths. These processes remove chemically bonded film from the surface of the wafer.

A further cleaning operation includes the use of mechanical scrubbing operations. These operations tend to be aggressive cleaning operations that use polishing pads affixed to turning tables that hold the substrate that is being polished. Due to the nature of this cleaning operation, the operation needs to be carefully monitored and special precaution needs to be taken to assure that particles that are removed during the operation are removed from the environment.

Typically, the turntable is rotated at various controlled speeds, for instance 10 to 100 RPM, in a controlled clockwise or counterclockwise direction. A silicon wafer, generally in the form of a flat, circular disk, is held within a carrier assembly with the substrate wafer face to be polished facing downward. The polishing pad is typically fabricated from a polyurethane and/or polyester base material.

Another field in the high density interconnect technology is the physical and electrical interconnection of many integrated circuit chips to a single substrate commonly referred to as a multi-chip module (MCM). A multi-layer structure is created on the substrate in order to achieve a high wiring and packing density. This multi-layer structure allows for short interconnects and improved circuit performance. Separation of the planes within the substrate, such as metal power and ground planes, is accomplished by separating the layers with a dielectric such as a polyimide. Metal conductor lines can be embedded in other dielectric layers with via openings that provide electrical connections between signal lines or to the metal power and ground planes.

In the indicated processes, great care is used to assure that the surfaces of interfaces have good planarity. In a multilayer structure, a flat surface is extremely important to maintain uniform processing parameters from layer to layer. Layer dependent processing greatly increases processing complexity. Many approaches to producing a planar surface have been incorporated into methods of fabricating high density interconnects and integrated circuit chips in the past. For instance, the lines and vias can be planarized by applying multiple coatings of polyimide which are used to achieve an acceptable degree of planarization. Application of multiple coatings of thick polyimide is however time consuming and creates high stress on the substrate.

The problems associated with prior art polyimide processes have become more troublesome. For example, one of the main difficulties with polyimide processes is that the profiles (i.e. slopes) of the polyimide at the bonding pad edges are not consistent. Rough edges or films having numerous flakes and other defects are pervasive throughout the prior art. In other cases, pieces of photoresist can sometimes become deposited on the surface of the bonding pads causing spikes of unetched passivation layer to be left behind on the bonding pad itself. Although these problems have not prevented the use of

conventional polyimide processes in conjunction with standard wire bonding techniques, these shortcomings are unacceptable in the newer, more advanced bonding.

All of the above indicated processing conditions and environments can lead to the introduction of a large number of contaminants and therefore lead to the need for strict control of the environment and the way in which the wafers that are being processed are being routed. Among the contaminants that can accumulate on the surface of a substrate are metals such as copper or aluminum. Control mechanisms that enhance the monitoring of the level of metal deposited on the surface of a wafer prevent unnecessary re-routing and rework of such wafers. Production cost of semiconductor wafers will be reduced if such wafers can be identified so that only wafers that need to be rerouted for rework are entered into the rework cycle.

US 5,820,689 (Tseng et al.) discloses a wet chemical treatment system.

US 5,552,327 (Bachmann et al.) shows a method for monitoring etching using reflectance spectroscopy.

US 5,840,368 (Ohmi) shows a furnace system.

US 5,683,180 (De Lyon et al.) shows a method of wafer temperature measurement using reflectivity spectroscopy.

US 5,364,510 (Carpio) shows a scheme for bath chemistry control.

SUMMARY OF THE INVENTION

It is the primary objective of the invention to identify semiconductor substrates that contain metal on the surface of the substrate.

It is a further objective of the invention to inhibit incorrect routing of wafers.

It is a further objective of the invention to eliminate unnecessary substrate rework activities.

It is a further objective of the invention to reduce the overall cost of substrate manufacturing.

It is yet another objective of the invention to reduce human error in the identifying and routing of substrates in the substrate manufacturing process.

It is yet another objective of the invention to reduce the workload for front-end cleaning sinks and furnaces.

It is yet another objective of the invention to prevent mixing of rework wafers with regular wafer processing flow.

It is yet another objective to prevent unnecessary wafer scrapping due to suspected metal contamination.

In accordance with the objectives of the invention, a new method of detecting and measuring the level of metal present on the surface of a substrate is achieved. A wafer can, at any time and at any location within the wafer processing cycle, be measured for the existence of metal on the surface of the layer. The presence of metal causes the raising of a visual or audible alarm thereby invoking human or automatic intervention.

Under the first embodiment of the invention, rf power is directed at the surface of a wafer, the reflected rf energy is captured and analyzed for intensity and frequency content. Based on this analysis conclusions can be drawn regarding presence and type of metal on the surface of the wafer.

Under the second embodiment of the invention, a source of light exposes the surface of the wafer under an angle such that part of the light reflects off this surface. The reflected light is captured and measured. Based on the measurements obtained in this manner, conclusions can be drawn concerning the reflectivity of the reflecting surface, that is the surface of the wafer. These conclusions lead directly to a measurement of the amount of metal present on the surface of the wafer.

Under the third embodiment of the invention, a magnetron radiates electromagnetic energy in the frequency range of microwave frequency. This energy is, under an angle, directed at the surface of the wafer that is being evaluated. Part of the energy is reflected by the surface of the wafer, another part passes through the wafer and can be measured after it has passed through the wafer. By comparing the level of the reflected energy with the level of the energy that passed through the wafer, conclusions can be drawn about the reflectivity of the wafer surface and therefore about the amount of metal that is present on the surface of the wafer.

BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 shows details of the implementation of the first embodiment of the invention, which uses an rf metal detector arrangement to measure the presence of metal on the surface of a wafer.

Fig. 2 shows details of the implementation of the second embodiment of the invention, which uses a light emitting diode for the source of energy that is reflected off the surface of the wafer.

Fig. 3 shows details of the implementation of the third embodiment of the invention, which uses a magnetron for the source of energy that is reflected off the surface of the wafer.

Fig. 4 shows a graph of the reflectivity of a SiO_2 layer deposited on Si as a function of wavelength.

Fig. 5 shows a graph of the reflectivity of a layer of AlCu as a function of wavelength.

Fig. 6a and 6b show two possible applications of the invention in re-routing wafers.

DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring now specifically to Fig. 1, there is shown an electronic circuit that serves as a means to identify and measure the amount of rf energy that is reflected by the surface of a wafer.

The electronic circuit contains three functional sections: a LC resonating circuit, a LC tuning circuit and a rectifying circuit.

RF energy of a certain frequency is generated by an rf generating circuit that comprises the amplifiers 14 and 16 and the LC tuning components 12 and 10. The resonating rf wave is amplified by amplifier 18 and passes through the second tuning circuit consisting of inductor 20 and capacitor 22. The second tuning circuit 20/22 selects specifically the rf frequency generated by the first tuning circuit 12 and 10. The selected wave is then amplified by amplifier 24 and rectified by diode 26 and capacitor 28 to form a dc signal.

When a wafer with a metal layer is brought in proximity with the coil 10, the inductance and the stray capacitance of the first resonating circuit changes. The frequency generated is

therefore shifted and can no longer pass through the second tuning circuit causing the dc output voltage to be reduced or to be eliminated. This triggers an alarm and produces a control signal that stops the subsequent action of putting the wafer into a cleaning sink or a furnace, thereby avoiding the contamination.

Fig. 2 shows an arrangement that has the same objectives as described under Fig. 1 above. In the implementation of the invention as shown in Fig. 2, the source of energy is a Light Emitting Diode (LED). The LED shown can be selected to generate light of different wavelengths, for instance red, green and blue. The light that is reflected by the surface 32 of wafer 30 can be detected by a photodetector 42. This photodetector is also sensitive to light of a particular frequency. Fig. 2b shows a graph indicating the reflectivity of metal as a function of frequency (or wavelength) of the light that is reflected. The vertical or Y-axis shows the amount of energy that is reflected, the horizontal or X-axis shows the wavelength of the light that is reflected. The type and amount of metal that is present in a reflecting surface can be identified by the amount of energy that the surface reflects. This amount of energy is different for the frequencies or wavelengths that are contained within the light that is reflected. Visible light contains many different

frequencies, in many applications red, green and blue are used for working purposes since these colors are the primary colors.

A given metal, for instance aluminum, reflects the three primary colors in a unique and identifiable way. For a particular metal, the reflectivity of each of the three primary colors is known. This means that for light of one particular frequency, for instance red, that is reflected by a known metal, for instance aluminum, the reflectivity values are known for this combination light with metal (for instance red with aluminum). From this it is clear that by measuring reflectivity of an unknown metal (the metal that must be identified) using a known light (frequency/wavelength), for instance red, and comparing this reflectivity measurement with the known (range of) reflectivity values that can be expected from various metals, the metal that fits the measured reflectivity profile can be identified.

By using the wavelengths of the three primary colors (red, green and blue) the amount of light that is reflected by the surface of the wafer (the reflectivity) by these primary colors can be measured (by the photodetector). The three primary colors have unique wavelengths, these wavelengths are indicated as three points on the X-axis of Fig. 2b. The Y-axis of Fig. 2b

indicates reflectivity values. The reflectivity values (Y-axis values) measured for the three primary colors (X-axis values) can then be plotted in Fig. 2b. The range of reflectivity values (Y-axis values) is, for a particular metal, known. If therefore the three measurements of reflectivity that have been obtained in the manner indicated fall within the (known) range for a particular metal, the conclusion is clear that the metal that is present on the reflecting surface (the surface of the wafer) is the same metal as the metal that belongs to that range of reflectivity values. Therefore, in measuring the reflectivity for 3 wavelengths, for instance 300, 500 and 700 nm, and if for all three points the measured reflectivity falls within the range of for instance aluminum, the conclusion is apparent that aluminum is present on the surface of the wafer. An automatic response mechanism can be implemented to respond to the presence of aluminum on the surface of the wafer. This can be implemented by using three LED's and three photodiodes and an "and" circuit that gives a signal when the output voltage of all three diodes falls within a specific range of values.

Fig. 3 uses a magnetron 50 as its source of radiation in the range of microwave frequencies. This radiation is again aimed under an angle at the wafer that is being tested. Part 56 of the energy that strikes the surface of the wafer is

reflected, part 58 of the energy penetrates the surface of the wafer and can be measured "behind" the wafer. The magnetron 50 is positioned approximately as shown with respect to the position of the wafer, microwave detector 52 measures the energy that has penetrated the wafer, microwave detector 54 measures the energy that is reflected by the surface 32 of the wafer 30. A strong reflection by the surface 32 of wafer 30 indicates the presence of metal on that surface, if therefore detector 54 measures a higher level of microwave energy than detector 52, it is clear that metal is present on the surface of the wafer. Automatic response mechanisms can be implemented that are activated either by the signal from the detector for reflection or by the detector for transmission or by subtracting the signal of one from the other.

Fig. 4 and 5 further emphasize the basic concept underlying the invention, that is that surface reflectivity is dependent on the type and concentration of the material contained within the reflecting surface and is dependent on the frequency of the wavelength of the energy that is reflected from this surface. Both Fig. 4 and Fig. 5 show the different reflectivity optical light of an SiO_2 surface as compared with an aluminum surface. Fig. 4 shows this correlation for a layer of SiO_2 layer that has been deposited on the surface of a layer of Si. Fig. 5 shows

this correlation for a layer of AlCu that has been deposited on the surface of a layer of Si. Figs. 4 and 5 apply to the LED - photodiode method only. It is clear that both correlations have very unique and identifiable characteristics, these characteristics are used as the basis for the invention. Most noteworthy in Fig. 4 is the seesaw nature of the reflectivity of the SiO_2 layer as the frequency of the reflected light decreases. Fig. 5 shows that, for AlCu, the reflectivity is and remains at a plateau from where the reflectivity only slowly decreases for relatively high frequencies in the reflected light.

Fig. 6 shows a side view of an implementation of the invention that lends itself to automatic handling of wafers based on the amount and type of metal on the surface of the wafer. The metal detector apparatus as described can be mounted as shown, facing the surface of the wafers and linked to a robotic arm that can be used to remove wafers from the teflon wafer holder. The action of removal is triggered by the level of detection reaching a level that indicates the presence of metal, the robotic arm removes the wafer in question and positions that wafer into another wafer carrier for further wafer processing. The operation of identifying contaminated (with metal) wafers is thereby automated and removed from human intervention and human

error. Wafers 62 are mounted in the wafer carrier 60, the source of energy 64 broadcasts the energy 68 to the surface 72 of the wafer 62, part 70 of the energy is reflected by the surface 72 and detected by the energy detector 66. This energy detector can readily determine the presence and type of metal, if any, which is present on the surface 72 of wafer 62.

Fig. 6b shows a top view of a similar arrangement that allows the application of using a magnetron as source of energy whereby the incident radiated energy 68 is partially reflected (74) by the surface of the wafer 62 and partially transverses (76) the wafer. Wafers 62 are mounted in the wafer carrier 60. By measuring and comparing the reflected energy 74 with the penetrated energy 76, conclusions can be drawn regarding the presence and type on metal on the surface of the wafer.

For the applications of the invention as shown in Figs. 6a and 6b, methods known in the art of wafer processing and wafer handling can be applied for removing wafers that have undesirable surface coatings of metal. These wafers, once removed from the normal wafer processing flow, can then be handled in accordance with required procedures established for such wafers.

Although the present invention is illustrated and described herein as embodied in the construction of a number of examples, it is nevertheless not intended to be limited to the details as presented. Rather, various modifications may be made in the details within the scope and range of equivalents of the claims and without departing from the spirit of the invention.

What is claimed is:

1. A method for identifying high metal surface content substrate comprising:

providing a semiconductor substrate;

providing a source of radiation of rf energy;

providing a rf energy measurement apparatus;

exposing the surface of said semiconductor substrate to said source of radiation of rf energy thereby including the substrate into the tuning circuit of the rf generator thereby changing the frequency of the rf wave due to the metal containing substrate thereby detecting the presence of metal;

comparing said dc voltage level with a limit voltage level; and

initiating intervention if said dc voltage level is below or equal to a predetermined value.

2. The method of claim 1 whereby said source of radiation of rf energy can radiate electrical energy within the rf frequency bandwidth whereby furthermore said source of radiation of energy is positioned in a stationary and well defined physical location both with respect to the surface of said substrate and with respect to said rf energy measurement apparatus whereby furthermore said source of rf energy is calibrated to provide a dc voltage level output of known value for each particular and unique rf frequency and for each particular and unique physical

configuration of location and orientation as to angular intersection and distance between radiated and captured rf energy with respect to the surface of said substrate.

3. The method of claim 1 wherein said rf energy measurement apparatus is an apparatus that can capture rf energy and that can, for each rf frequency, measure the energy level of the captured energy whereby furthermore said rf energy measurement apparatus is to be positioned in a stationary and well defined physical location both with respect to the surface of said substrate and with respect to said source of radiation of rf energy whereby furthermore said rf energy measurement apparatus is calibrated to provide a dc voltage level output of known value for each particular and unique rf frequency and for each particular and unique physical configuration of location and orientation as to angular intersection and distance between radiated and captured rf energy with respect to the surface of said substrate.

4. The method of claim 1 whereby said exposing the surface of said semiconductor substrate to rf radiation is directing said rf energy at the active side of said semiconductor substrate whereby the direction of said rf exposure is essentially under an angle with the plane of said semiconductor

substrate whereby said angle is within the range between about 30 and 60 degrees.

5. The method of claim 1 wherein said measuring said reflected rf energy is creating a dc voltage level that is directly proportional to and indicative of the energy level of said reflected rf energy said dc voltage level being available to stimulate or activate a device that enables activating an alarm or warning signal thereby invoking human intervention.

6. The method of claim 1 wherein said comparing said voltage level with a predetermined or limit voltage level is determining whether said dc voltage level that is indicative of said rf energy is higher, lower or equal to a pre-set or adjustable limit voltage value thereby furthermore providing an electrical signal that reflects the outcome of said determination said electrical signal to indicate that the result of said compare is either a higher compare or an equal compare or a lower compare.

7. A method for identifying high metal surface content substrate comprising:

providing a semiconductor substrate;

providing a Light Emitting Diode;

providing a light reflectivity measurement apparatus;

setting the light emitted by said Light Emitting Diode to a certain wavelength;

exposing the surface of said semiconductor substrate to the light emitted by said Light Emitting Diode;

capturing the light reflected by said surface of said semiconductor substrate thereby driving said light reflectivity measurement apparatus;

measuring the reflectivity of said reflected light;

comparing said reflectivity of said reflected light with a predetermined light reflectivity value; and

initiating intervention if said reflectivity is within a predetermined range of values.

8. The method of claim 7 whereby providing a Light Emitting Diode (LED) is providing a LED that can radiate electrical energy within the light frequency bandwidth whereby furthermore said LED is positioned in a stationary and well defined physical location both with respect to the surface of said substrate and with respect to said light reflectivity measurement apparatus whereby furthermore said LED is calibrated to provide a reflectivity value for each particular and unique light frequency and for each particular and unique physical configuration of location and orientation as to angular

intersection and distance between emitted and captured light energy with respect to the surface of said substrate.

9. The method of claim 7 whereby said light is red light followed by green light followed by blue light.

10. The method of claim 7 wherein said light reflectivity measurement apparatus is an apparatus that can capture light energy and that can, for each light frequency, measure the reflectivity of the captured light energy whereby furthermore said light reflectivity measurement apparatus is to be positioned in a stationary and well defined physical location both with respect to the surface of said substrate and with respect to said LED whereby furthermore said light reflectivity measurement apparatus is calibrated to provide a reflectivity of known value for each particular and unique light frequency and for each particular and unique physical configuration of location and orientation as to angular intersection and distance between radiated and captured light energy with respect to the surface of said substrate.

11. The method of claim 7 whereby said exposing the surface of said semiconductor substrate to the light emitted by said Light Emitting Diode is directing said Light Emitting Diode

light at the active side of said semiconductor substrate whereby the direction of said LED light exposure is essentially under an angle with the plane of said semiconductor substrate whereby said angle is within the range between about 30 and 60 degrees whereby furthermore said LED is positioned in a stationary and well defined physical location both with respect to the surface of said substrate and with respect to said light reflectivity measurement apparatus.

12. The method of claim 7 wherein said measuring said reflected light energy is measuring the reflectivity of said captured light energy thereby having the ability to identify said light reflectivity in accordance with the frequency or wavelength of said captured light energy thereby furthermore having the ability to determine the reflectivity of said captured light energy for each of said identified captured light frequencies or wavelengths.

13. The method of claim 7 wherein said comparing said reflectivity of said reflected light with a predetermined light reflectivity is determining whether said reflectivity of said reflected light is higher than, lower than or within a range of reflectivity values thereby furthermore providing an electrical signal that reflects the outcome of said determination said

electrical signal to indicate that the result of said compare is either a high compare or an equal compare or a low compare.

14. A method for identifying high metal surface content substrate comprising:

providing a semiconductor substrate;

providing a source of microwave radiation;

providing a first and second microwave energy measurement apparatus;

exposing the surface of said semiconductor substrate to microwave radiation;

capturing microwave energy reflected by said surface of said semiconductor substrate thereby driving said first microwave energy measurement apparatus;

capturing microwave energy passed through said semiconductor substrate thereby driving said second microwave energy measurement apparatus;

measuring said reflected microwave energy;

measuring said passed through microwave energy;

comparing said reflected microwave energy with said passed through microwave energy; and

initiating intervention if said reflected microwave energy exceeds said passed through microwave energy.

15. The method of claim 14 whereby said providing a source of microwave radiation is providing a source of energy that can radiate energy within the microwave frequency bandwidth whereby furthermore said source of microwave radiation is positioned in a stationary and well defined physical location both with respect to the surface of said substrate and with respect to said first and second microwave energy measurement apparatus whereby furthermore said source of microwave energy is calibrated to provide an output signal of known value for each particular and unique microwave frequency and for each particular and unique physical configuration of location and orientation as to angular intersection and distance between radiated and captured microwave energy with respect to the surface of said substrate.

16. The method of claim 14 wherein said first and second microwave energy measurement apparatus is an apparatus that can capture microwave energy and that can measure the energy level of the captured energy whereby furthermore said first and second microwave energy measurement apparatus is to be positioned in a stationary and well defined physical location both with respect to the surface of said substrate and with respect to said source of microwave radiation whereby furthermore said first and second microwave energy measurement apparatus is calibrated to provide

a signal level of known value for each particular and unique physical configuration of location and orientation as to angular intersection and distance between radiated and captured rf energy with respect to the surface of said substrate.

17. The method of claim 14 whereby said exposing the surface of said semiconductor substrate to microwave radiation is directing said source of microwave radiation at the active side of said semiconductor substrate whereby the direction of said microwave radiation is essentially under an angle with the plane of said semiconductor substrate whereby said angle is within the range between about 30 and 60 degrees whereby furthermore said source of microwave radiation is positioned in a stationary and well defined physical location both with respect to the surface of said substrate and with respect to said first and second microwave energy measurement apparatus.

18. The method of claim 14 wherein said capturing microwave radiation reflected by said surface of said semiconductor substrate is introducing said microwave radiation into said first microwave energy measurement apparatus.

19. The method of claim 14 wherein said measuring said reflected microwave energy is creating a signal of said microwave energy that is directly proportional to and reflective of the energy level of said reflected microwave radiation.

20. The method of claim 14 wherein said measuring said microwave energy that passed through said semiconductor substrate is creating a signal of said microwave energy that is directly proportional to and reflective of the energy level of said passed through microwave energy.

21. The method of claim 14 wherein said comparing said reflected microwave energy with said passed through microwave energy is determining whether said reflected microwave energy is larger than said passed through microwave energy thereby furthermore providing an electrical signal that reflects and indicates that said reflected microwave energy is larger than said passed through microwave energy.

22. An apparatus for identifying high metal surface content substrate comprising:

a source of radiation of rf energy;

a rf energy measurement apparatus;

a means for exposing the surface of said semiconductor substrate to said source of radiation of rf energy;

a means for capturing rf energy reflected by said surface of said semiconductor substrate thereby driving said rf energy measurement apparatus;

a means for measuring said reflected rf energy thereby providing a dc voltage level that is indicative of the amount of rf energy that is reflected by the surface of said substrate;

a means for comparing said dc voltage level with a limit voltage level; and

a means for initiating intervention if said dc voltage level is above or equal to a predetermined value.

23. The apparatus of claim 22 whereby said source of radiation of rf energy can radiate electrical energy within the rf frequency bandwidth whereby furthermore said source of radiation of energy is positioned in a stationary and well defined physical location both with respect to the surface of said substrate and with respect to said rf energy measurement apparatus whereby furthermore said source of rf energy is calibrated to provide a dc voltage level output of known value for each particular and unique rf frequency and for each particular and unique physical configuration of location and orientation as to angular intersection and distance between

radiated and captured rf energy with respect to the surface of said substrate.

24. The apparatus of claim 22 wherein said rf energy measurement apparatus is an apparatus that can capture rf energy and that can, for each rf frequency, measure the energy level of the captured energy whereby furthermore said rf energy measurement apparatus is to be positioned in a stationary and well defined physical location both with respect to the surface of said substrate and with respect to said source of radiation of rf energy whereby furthermore said rf energy measurement apparatus is calibrated to provide a dc voltage level output of known value for each particular and unique rf frequency and for each particular and unique physical configuration of location and orientation as to angular intersection and distance between radiated and captured rf energy with respect to the surface of said substrate.

25. The apparatus of claim 22 whereby said means for exposing the surface of said semiconductor substrate to rf radiation is directing said rf energy at the active side of said semiconductor substrate whereby the direction of said rf exposure is essentially under an angle with the plane of said

semiconductor substrate whereby said angle is within the range between about 30 and 60 degrees.

26. The apparatus of claim 22 wherein said means for measuring said reflected rf energy is creating a dc voltage level that is directly proportional to and indicative of the energy level of said reflected rf energy said dc voltage level being available to stimulate or activate a device that enables invoking an alarm or warning signal thereby invoking human intervention.

27. The apparatus of claim 22 wherein said means for comparing said voltage level with a predetermined or limit voltage level is determining whether said dc voltage level of said rf energy is higher, lower or equal to a pre-set or adjustable limit voltage value thereby furthermore providing an electrical signal that reflects the outcome of said determination said electrical signal to indicate that the result of said compare is either a higher compare or an equal compare or a lower compare.

28. An apparatus for identifying high metal surface content substrate comprising:

a Light Emitting Diode;

a light reflectivity measurement apparatus;

a means for setting the light emitted by said Light Emitting Diode to a certain wavelength;

a means for exposing the surface of said semiconductor substrate to the light emitted by said Light Emitting Diode;

a means for capturing the light reflected by said surface of said semiconductor substrate thereby driving said light reflectivity measurement apparatus;

a means for measuring the reflectivity of said reflected light;

a means for comparing said reflectivity of said reflected light with a predetermined light reflectivity value; and

a means for initiating intervention if said reflectivity is within a predetermined range of values.

29. The apparatus of claim 28 whereby a Light Emitting Diode (LED) is a LED that can radiate electrical energy within the light frequency bandwidth whereby furthermore said LED is positioned in a stationary and well defined physical location both with respect to the surface of said substrate and with respect to said light reflectivity measurement apparatus whereby furthermore said LED is calibrated to provide a reflectivity value each particular and unique light frequency and for each particular and unique physical configuration of location and orientation as to angular intersection and distance between

emitted and captured light energy with respect to the surface of said substrate.

30. The apparatus of claim 28 whereby said light is red light followed by green light followed by blue light.

31. The apparatus of claim 28 wherein said light reflectivity apparatus is an apparatus that can capture light energy and that can, for each light frequency, measure the reflectivity of the captured light energy whereby furthermore said light reflectivity measurement apparatus is to be positioned in a stationary and well defined physical location both with respect to the surface of said substrate and with respect to said LED whereby furthermore said light reflectivity measurement apparatus is calibrated to provide a reflectivity of known value for each particular and unique light frequency and for each particular and unique physical configuration of location and orientation as to angular intersection and distance between radiated and captured light energy with respect to the surface of said substrate.

32. The apparatus of claim 28 whereby said means for exposing the surface of said semiconductor substrate to the light emitted by said Light Emitting Diode is directing said Light Emitting

Diode light at the active side of said semiconductor substrate whereby the direction of said LED light exposure is essentially under an angle with the plane of said semiconductor substrate whereby said angle is within the range between about 30 and 60 degrees whereby furthermore said LED is positioned in a stationary and well defined physical location both with respect to the surface of said substrate and with respect to said light reflectivity measurement apparatus.

33. The apparatus of claim 28 wherein said means for measuring said reflected light energy is measuring the reflectivity of said captured light energy thereby having the ability to identify said light reflectivity in accordance with the frequency or wavelength of said captured light energy thereby furthermore having the ability to determine the reflectivity of said captured light energy for each of said identified captured light frequencies or wavelengths.

34. The apparatus of claim 28 wherein said means for comparing said reflectivity of said reflected light with a predetermined light reflectivity is determining whether said reflectivity of said reflected light is higher than, lower than or within a range of reflectivity values thereby furthermore providing an electrical signal that reflects the outcome of said

determination said electrical signal to indicate that the result of said compare is either a high compare or an equal compare or a low compare.

35. A apparatus for identifying high metal surface content substrate comprising:

a source of microwave radiation;

a first and second microwave energy measurement apparatus;

a means for exposing the surface of said semiconductor substrate to microwave radiation;

a means for capturing microwave energy reflected by said surface of said semiconductor substrate thereby driving said first microwave energy measurement apparatus;

a means for capturing microwave energy passed through said semiconductor substrate thereby driving said second microwave energy measurement apparatus;

a means for measuring said reflected microwave energy;

a means for measuring said passed through microwave energy;

a means for comparing said reflected microwave energy with said passed through microwave energy; and

a means for initiating intervention if said reflected microwave energy exceeds said passed through microwave energy.

36. The apparatus of claim 35 whereby said a source of microwave radiation is a source of energy that can provide energy within the microwave frequency bandwidth whereby furthermore said source of microwave radiation is positioned in a stationary and well defined physical location both with respect to the surface of said substrate and with respect to said first and second microwave energy measurement apparatus whereby furthermore said source of microwave energy is calibrated to provide an output signal of known value for each particular and unique microwave frequency and for each particular and unique physical configuration of location and orientation as to angular intersection and distance between radiated and captured microwave energy with respect to the surface of said substrate.

37. The apparatus of claim 35 wherein said first and second microwave energy measurement apparatus is an apparatus that can capture microwave energy and that can measure the energy level of the captured energy whereby furthermore said first and second microwave energy measurement apparatus is to be positioned in a stationary and well defined physical location both with respect to the surface of said substrate and with respect to said source of microwave radiation whereby furthermore said first and second microwave energy measurement apparatus is calibrated to provide

a signal level of known value for each particular and unique physical configuration of location and orientation as to angular intersection and distance between radiated and captured rf energy with respect to the surface of said substrate.

38. The apparatus of claim 35 whereby said means of exposing the surface of said semiconductor substrate to microwave radiation is directing said source of microwave radiation at the active side of said semiconductor substrate whereby the direction of said microwave radiation is essentially under an angle with the plane of said semiconductor substrate whereby said angle is within the range between about 30 and 60 degrees whereby furthermore said source of microwave radiation is positioned in a stationary and well defined physical location both with respect to the surface of said substrate and with respect to said first and second microwave energy measurement apparatus.

39. The apparatus of claim 35 wherein said means of measuring said reflected microwave energy is creating a signal of said microwave energy that is directly proportional to and reflective of the said reflected microwave radiation.

40. The apparatus of claim 35 wherein said means of measuring said microwave energy that passed through said semiconductor substrate is creating a signal of said microwave energy that is directly proportional to and reflective of the said passed through microwave energy.

41. The apparatus of claim 35 wherein said means of comparing said reflected microwave energy with said passed through microwave energy is determining whether said reflected microwave energy is larger than said passed through microwave energy thereby furthermore providing an electrical signal that reflects and indicates that said reflected microwave energy is larger than said passed through microwave energy.