

**DESCRIPTION - A PROCEDURE AND DEVICE FOR IDENTIFYING THE
CHARACTERS ON A SEMI-CONDUCTOR WAFER WITH AT LEAST ONE
ORIENTATION MARK.**

10 The invention relates to the field of manufacturing electronics components, and particularly the manufacture of integrated circuits from substrates or wafers of semi-conductor material such as silicon. More especially, it relates to the procedures and equipment used to identify the characters appearing on semi-conductor wafers bearing at least one orientation mark.

11 Several procedures and equipment already exist for reading characters on semi-conductor wafers. We are aware, in particular, of one reading procedure for characters engraved on wafer-style substrates that consists of a manipulator arm holding each wafer horizontally, the wafers being arranged in rows, one behind the other in the appropriate slots of a vertically-mounted rack. The arm withdraws the wafer from the rack and then rotates it with the aid of an orientation mark on the wafer's rim in the form of a slot or flat so as to place that part of the surface bearing the characters to be read in front of, and at right angles to, a camera's optical centre line and lighting system. The major disadvantage of this procedure is related to the need for the wafer to be withdrawn from its housing for no other reason than to identify it. An added disadvantage lies in the introduction of a number of items above the wafer that might contaminate it.

21 We also know of another solution that rotates and identifies a number of wafers housed in a single rack within one individual item of equipment unit but for which the camera and lighting system are arranged above the wafers, thus causing significant air turbulence and a particular risk of contaminating of the wafers.

31 The applicant has developed procedures and devices to remedy these disadvantages by utilising special lighting and viewing angles that allow the characters on the semi-conductor wafers to be read from below. Such procedures and devices are described in particular detail in the document FR 2 711 824. Although these procedures and devices are completely satisfactory, they do, however, require that all the wafers be correctly aligned beforehand in their housing.

41 The document WO 91/10968 shows several procedures and devices that read characters using at least one mirror to reflect light rays that are then used to identify characters engraved more or less deeply into the wafers. In particular, this document describes a device that identifies characters engraved into silicon wafers arranged within a rack, a device in which radiated light is reflected across one or two mirrors before illuminating the characters on the wafer to be identified. The image of the characters thus illuminated is reflected over two mirrors within the device before entering into a camera reader. In order to illuminate the characters engraved on one of the wafers arranged within the

rack, the device includes a mechanism to raise the wafer directly in front of the wafer to be identified so that a mirror may then be positioned in front of the characters, the mirror being positioned at 45° with respect to the plane of the wafer. This device has the disadvantage of needing to move one wafer in order to read another, which may bring the risk of contamination for the wafers whilst also slowing down the identification time due to the manipulations required. In addition, this device uses several mirrors to read the illuminated characters, thus leading to increased mechanical complexity and a greater sales cost for the device whilst also risking errors in wafer identification due to the multiple reflection of the image before it enters the camera reader.

The applicant has developed procedures and devices for reading characters on semi-conductor wafers that, to a large extent, solve the above-mentioned disadvantages by taking advantage of a single reflecting mirror, as described in the document FR 2 751 769. The procedures and devices described in that document may be successfully used to read characters written more or less deeply on a semi-conductor wafer without handling the wafer to be identified itself or any other wafer. This is due to a special arrangement of the lighting and reading systems that use one mirror, inserted from below, between two successive wafers, to reflect the light falling on the characters to be identified. These procedures and devices have also proved entirely satisfactory. However, as with the procedures and devices in the aforementioned document FR 2 711 824, they require the semi-conductor wafers themselves to be correctly aligned for the characters to be read to be aligned properly.

The present invention is intended to solve the disadvantages of existing procedures and devices whilst incorporating additional advantages. More precisely, it consists of a procedure to identify the characters written on a semi-conductor wafer with at least one orientation mark. The procedure may be identified in that it consists of the following stages:

- Gripping the semi-conductor wafer by seating its rim between at least three stop rollers on a pick-up arm,

- Orienting the said semi-conductor wafer, once gripped, by turning at least one of the at least three stop rollers in such a way as to place the orientation mark in a pre-determined position,

- Positioning the dedicated light ray reflector mechanism within a space approximately alongside the said characters to be identified and above them,

- Illuminating the characters to be identified by means of a dedicated beam of light reflected by the said reflector mechanism onto the characters to be identified,

- Reading the characters to be identified by means of the light rays reflected by the characters,

- Identifying the said characters.

The procedure according to the invention, by combining the grip on the rim of the wafer bearing the characters to be identified with the rotation or alignment of these characters into a position in which they may be identified and

the use of a special mirror to identify the more or less deeply engraved characters, offers an identification procedure that minimises the contamination risks by only handling those wafer that need to be identified, and then only by their rims, whilst also aligning and identifying the characters.

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As one advantageous feature, the invention's procedure consists of gripping the semi-conductor wafer by its rim using at least three stop rollers whilst simultaneously placing the light rays' reflector mechanism in the space more or less next to and above the position that the characters will occupy once the wafer has been aligned.

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This feature represents a saving in time and machinery whilst also offering a simpler, and thus less costly and more reliable procedure since, with just one operation, the wafer may be gripped and the reflector positioned at the same time.

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As a further advantage, the invention's procedure includes the positioning of a light shield mechanism at the same time as the reflector mechanism in the same space to stop ambient light interfering with the characters to be identified.

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This feature improves performance by identifying the characters on the semi-conductor wafer without extending the procedure's duration since the act of positioning the shields takes place at the same time as the positioning of the reflector mechanism.

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As a further advantage, the invention's procedure includes the movement of the semi-conductor wafer through space, either after the identification of the characters or at the same time as some other action, ie, whilst orienting the semi-conductor wafer or illuminating, reading or identifying the characters.

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This feature of the invention's procedure offers great flexibility in use since the actions mentioned may, as a result, take place concurrently, eg, as the wafer to be identified is moving from one point to another.

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As a further advantage, the invention's procedure includes a stage in which the said semi-conductor wafer is gripped by seating its rim between at least three stop rollers connected to a pick-up arm, a stage that consists of three steps, as follows:

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- Inserting the pick-up arm with its at least three stop rollers into the immediate vicinity of a semi-conductor wafer in its semi-conductor wafer housing, by means of an initial arm movement in at least one initial direction,

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- Locating the semi-conductor wafer between the at least three stop rollers by means of a second arm movement in a second direction,

- Placing the at least three stop rollers on the pick-up arm in contact with the semi-conductor plate's rim.

The procedure also includes the following stages after the identification

of the characters:

- Removing the said reflector mechanism from the area more or less alongside and above the characters,

- Freeing the semi-conductor wafer from the grip of the at least three stop rollers,

- Removing the semi-conductor wafer from the pick-up arm by means of a third arm movement in a third direction, opposite to the second direction,

- Withdrawing the pick-up arm from the immediate vicinity of the wafer by means of a fourth arm movement opposite to the initial direction.

This invention also covers a device to identify the characters written on semi-conductor wafers with at least one orientation mark and that may be used to implement the invention's general procedure. It may be identified in that it consists of:

- A rigid pick-up arm with, in one fixed plane, at least one first and one second stop roller, each free to rotate at least around its own centre line, and a third stop roller free to rotate around at least its own centre line and also free to move within the fixed plane. These first, second and third stop rollers are used to pick up a semi-conductor wafer by its rim,

- A motion mechanism for the third stop roller within the fixed plane,

- An orientation mechanism for the semi-conductor wafer, consisting of a rotary drive mechanism using at least one of the first, second or third stop rollers,

- A reflector mechanism for the light rays,

- A motion mechanism for the reflector mechanism,

- An illumination mechanism for the said characters, consisting of at least one light beam,

- A mechanism for reading the said characters,

- An mechanism for identifying the said characters.

As a further advantage, the third stop roller, with its freedom to move within the fixed plane, is coupled with the light ray reflector mechanism such that the motion mechanism for the third stop roller moves together with the light ray's reflector mechanism in both directions.

As a further advantage, the invention's device includes a light shield mechanism to stop ambient light interfering with the identification of the characters, coupled to the reflector mechanism such that the reflector's motion mechanism and the light shield mechanism move together.

As a further advantage, the invention's device includes mechanisms to move the said pick-up arm through space.

As a further advantage, the said spatial motion mechanisms for the pick-up arm include at least:

- A mechanism to move the said pick-up arm through its initial direction in space, and back again,
- A mechanism to move the said pick-up arm through its second direction in space, and back again,
- 10 - A mechanism to move the said pick-up arm through its third direction in space, and back again.

Further features and advantages will become apparent when reading the description below of one example of the invention's procedure and device, with the attached drawings. The example is intended only to illustrate the invention and is not to be considered
15 comprehensive.

Figure 1 is a perspective view of one means of constructing the invention's character-reading device in its initial operating position.

20 Figure 2 is a perspective view of the construction method in Figure 1, shown from another angle and in its second operating position.

Figure 3 is a plan view of the character-reading device shown in Figure 1.

25 Figure 4 is a cross section along the line I-I in Figure 3.

Figure 5 is an enlarged detail view from below, from the direction F in Figure 1.

Figure 6 is a detailed but partial side view, from the direction G in Figure 3.
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Figure 7 is an enlarged plan view of the detail in Figure 6.

Figure 8 is an enlarged detail view from Figure 4.

35 Figure 9 is a centre line cross-section of enlarged detail from Figure 1.

A device 1 for reading the characters 2 on a semi-conductor wafer 3 with at least one orientation mark 4 is shown in Figures 1 to 4 and includes:

- One rigid pick-up arm 5 with, in a fixed plane 11, a first 6 and second 7 stop roller, each
40 free to rotate about its own centre line, and a third 8 stop roller free to rotate about its own centre line and also free to move within the fixed plane 11. The first 6, second 7 and third 8 stop rollers are used to grip a semi-conductor wafer 3 by its rim 9.
- A mechanism 10 to move the third 8 stop roller within the fixed plane 11,
- A mechanism to orientate the semi-conductor wafer 3, consisting of a rotary drive
45 mechanism 12 for the third stop roller 8,
- A reflector mechanism 13 for the light rays,
- A mechanism 14 to move the reflector mechanism 13,
- A lighting mechanism 15 for the characters 2 written on the semi-conductor wafer 3,

using at least one light beam.

- A reading mechanism 16 for the characters 2 written on the semi-conductor wafer 3,
- An identification mechanism for the characters 2 written on the semi-conductor wafer 3.

5 The rigid pick-up arm 5 consists of any rigid structure 17, eg, a framework or metallic chassis, ideally hollowed out as shown in the diagrams on order to save weight, to which are attached the various component parts of the device described above and further detailed below.

10 The rigid structure 17 approximates in shape to a hollowed-out rectangle of fixed dimensions with optional reinforcing ribs 18, 19 in the corners, as shown in Figure 1. The rigid structure 17 ideally extends parallel to a plane 11 representing the flat surface of a semi-conductor wafer 3 and covering at least the full extent of this surface for one dimension or side of the rectangle to allow for the location of the stop rollers 6, 7 and 8
15 such that the semi-conductor wafer seats itself between them as shown in Figure 2. The stop rollers 6 and 7 are placed approximately at the two corners 20 and 21 forming the limits of the rectangle's first small side 50 such that when the moving stop 8 is located against the rim of the wafer 3, the force exerted on the rim of the semi-conductor wafer 3 is directed between the two seating points in the form of the stop rollers 6 and 7 such that the
20 wafer is held between the three stops 6, 7 and 8. The second small side of the rectangle is used for the rigid connection between the pick-up arm 5 and the mechanism used to move it in all three spatial directions, X, Y and Z using any known method, eg, by means of a rigid connection to a moving arm support capable of travelling in the spatial directions X, Y and Z at right angles to one another.

25 The stops 6 and 7 are free stop rollers mounted on bearings or rollers. These stops 6 and 7 may each advantageously be built up from two wheels 22 next to one another, as shown in Figure 1, in order to improve the stability and rotary guidance of the wafer 3. Each of the stops 6 or 7, or their component wheels 22, has an axis of rotation, in the
30 example perfectly or nearly vertical, and a suitable circular rolling strip such that when the wafer 3 rotates (via its rim seated on the on the rolling strips on the stops 6, 7) it does not accidentally slip off the rolling strip. In this case, we call the rim of the semi-conductor wafer that section of the wafer, either circular or nearly so, whether continuous or nearly so (by reason of some orientation mark), that excludes its upper or lower faces. As shown in
35 Figure 9, an example of a wheel 22 in longitudinal cross section, the stop rollers 6 and 7 are designed to this end, eg, with a vertical rotary axis 66 and a rolling strip 63 with a vertical profile, the rolling strip or stop roller having an upper lip 65 forming a stop to prevent the wafer coming off

...upwards from the rolling strip when the three stops 6, 7 and 8 are seated against the wafer's rim. The stop rollers 6 and 7, or their rolling strips 63, will each also be fitted with a lower lip 64 below the rolling strip to prevent the wafer coming off downwards from the rolling strip and to guide the semi-conductor wafer as it seats on the rolling strip under the effort of the stop roller 8, as shown in Figure 9.

The stop roller 8 is itself driven and used to drive the wafer in rotation between the three stop rollers 6, 7 and 8. The stop roller 8 has two positions, an initial position in which it is kept back from the wafer's rim, thus allowing the insertion of the arm 5 and its three stops 6, 7 and 8 around the rim of the wafer 3 without actually touching it. This is achieved by means of a movement of the pick-up arm 5 in the Z-axis direction, at right angles to the plane 11. In its second position, the stop roller 8 bears against the rim of the wafer 3 in order to drive it in rotation by friction. As an advantage, the stop roller 8 has a circular rolling strip with a cross section in the form of a throat, eg, the V-shape shown in Figure 8, such that the semi-conductor wafer 3 naturally starts to turn, perhaps in a helix for a short period, from the time of its contact with the edge of the throat until it is wedged in the base of the throat in a stable, rotating position, thus avoiding any accidental slippage of the wafer away from the rolling strip during its rotation. The inclusion of a V-shaped rolling strip on the driven stop 8 thus provides, in the form of the upper and lower arms of the V, the upper and lower lips described above for the free stop rollers 6 and 7.

As shown in Figure 5, the motion mechanism 10 for the third stop roller 8 within the fixed plane 11, consist of a lever arm 23, at one end of which the stop roller 8 is attached and free to rotate about an axis of rotation 24 when driven by the rotary drive motor 25 for the lever arm 23. The driven stop roller 8 bears against the wafer's rim, ideally under constant pressure rather than under constant position in order to provide improved drive for the stop roller 8. The action of the drive motor 25 on the lever arm 23 and the stop roller 8 against the rim of the wafer 3 is achieved by controlling the current supplied to the motor 25, running under direct current, and thus allowing the action of the stop 8 to take place at a controlled constant pressure. Note that the constant pressure operation of the drive stop roller may be provided in some other form, eg, pneumatically or by a spring, in which case its operation would not be, in absolute terms, at constant pressure. We shall see, however, that, under the present and preferred method of construction, the drive stop roller 8 moves, by virtue of the lever arm 23, through the plane 11 in the form of a circular arc, the pivot 24 of the lever arm 23 and the spindle 31 of the stop roller 8 being at right angles to the plane 11. Note too that the approach of the stop against the semi-conductor wafer's rim takes place in two stages to avoid striking the stop against the wafer. During the first stage of the approach

... the lever arm's drive motor is controlled by positional feedback and at the end of this first stage, the stop 8 lies in the immediate vicinity of the semi-conductor wafer. During the second stage, the stop 8 comes into contact with the wafer and presses against it whilst the wafer turns. The motor 25 is controlled by the current flowing through the motor throughout this second stage.

The semi-conductor wafer 3's orientation mechanism consists of a rotary drive mechanism 12 for the third stop roller 8 consisting of a second motor 26 driving the stop 8 in rotation by means of a transmission system 27 with two gears 28 and 29. The motor 26 is rigidly attached to the arm 5 opposite the motor 25 on the second short side of the rigid structure 17 forming the arm 5. The motor 25 is also rigidly attached to the arm 5 as shown in Figures 1 to 3. As shown in Figure 5, the transmission system 27 consists of two gears 28 and 29 in sequence, the first gear 28 transmitting the rotary motion from the shaft 30 of the motor 26 to the pivot 24 of the lever arm 23, whilst a second gear 29 transmits the rotary motion of the pivot 24 on lever arm 23 to the spindle 31 of the stop roller 8. Note that the drive stop 8 is ideally set in rotary motion before coming into contact with the rim of the wafer 3 to prevent any skidding by the semi-conductor wafer in the base of the throat after contact has been established between the rolling strip on the stop roller 8 and the rim 9 of the wafer 3. In this way, the wafer 3 will settle itself into the base of the throat in the stop roller 8 by means of a gradual helical motion as explained above, avoiding any sudden skidding of the wafer that might have occurred if the stop roller 8 had been set in rotary motion after coming into contact with the rim of the semi-conductor wafer 3.

As an advantage, the mechanism for orientating the semi-conductor wafer 3 consists of three position sensors 40, 41 and 42 to find the slot 4 in the wafer 3. The three slot position sensors 40, 41 and 42 are optical sensors, each with a light ray emitter and receiver, operating on the principle of reflected light beams. The sensors are situated on the rigid structure 17 on a pitch diameter slightly less than that of the external diameter of the semi-conductor wafer 3 and on which the wafer's orientation mark will also lie, somewhere along the length of the second short side forming the rectangle of the rigid structure 17, as shown in Figure 3, for instance. A first 40 and a second 41 sensor are placed at either end of the rectangle's short side, whilst the third sensor 42 is placed between the first and second sensors, exactly at the point where the slot 4 of the semi-conductor wafer 3 must lie for the characters to be identified. The sensors 40, 41 and 42 are attached to the rigid structure 17 such that when the slot passes over one of the sensors as the wafer rotates, the light beam emitted by the sensor passes through the slot and is thus no longer reflected by the wafer. The sensor's reflected light receiver then no longer receives the light rays and sends a slot position signal to the device's central control unit (not shown) that marks this position and decides on the action to

... take next. In this case, the central sensor 42 is used to stop the wafer rotating by stopping the drive motor 26 of the stop roller 8, whilst the lateral sensors 40 and 41 are used to decelerate the wafer as the slot passes over either one of them. In this way, without their being obligatory, the lateral sensors have the advantage of allowing a higher angular approach velocity for the wafer. Alternatively, the character reading mechanism 16 may be used to replace the central sensor 42, with the camera 38 being used to detect the slot's position in the same way as the central sensor, thus stopping the wafer's rotation when the slot is detected in exactly the right place for the identification of the characters.

- 10 The reflector mechanism for the light rays consists of a flat mirror 13 whose area is more or less the same or, ideally, slightly larger than that of the characters to be read on the semi-conductor wafer 3, ie, in this case, an approximately rectangular surface area whose length is greater than its width. The mirror 13 is combined with the lever arm 23 for moving the mobile stop roller 8 along the first of its short sides by means of a rigid
- 11 connection allowing a precise transmission of any movement of the lever arm 23 to the mirror 13 such that when the driven stop roller 8 is in its initial position of, clear of the wafer's 3 rim, the mirror 13 is located outside the area reserved for the wafer over the rigid structure, as shown in Figure 1. In the driven stop roller's 8 second position, against the rim of the wafer 3, the mirror 13 is located in a space 62 more or less alongside and above the
- 20 characters to be identified, as shown in Figure 2. The driven stop roller 8 and the mirror 13 both move forwards from the rear of the arm 5 in order to pass from the initial, neutral position to the second, active position so that the wafer may be driven in rotation. We shall see that pressing the driven stop roller 8 against the rim of the semi-conductor wafer provides the mirror 13, connected to the said stop roller, with its precise position input
- 25 relative to the semi-conductor wafer.

- In the example shown, the mechanism 14 for moving the reflector mechanism 13 therefore includes the lever arm 23 and the rotary drive motor 25 for the lever arm 23. The exact position of the mirror 13 in its initial position must allow the arm to move in the Z-axis in order to place a wafer 3 between the three stop rollers 6, 7 and 8, and the mirror 13 must not form an obstacle during this movement. It must therefore lie outside a perimeter equivalent to that of the wafer and the exact position of the mirror 13 in its second position is dependent on the location of the characters written on the semi-conductor wafer 3 and must also allow the illumination of these characters as explained below and later on. At
- 30 this time, the characters are generally written along one chord of the wafer's 3 circular rim in the area next to the edge. In this case, the mirror 13 must, in its second position, be situated with its long side parallel with this chord and more or less above the characters, the rim of the wafer being defined for the device 1 by the circle touching the three stops 6, 7 and 8, where the

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... stop 8 is considered as being in its second position touching the rim of the wafer. In this second position, the long side of the mirror 13 is more or less parallel with the short side of the rectangle forming the rigid structure 17. In practice, the orientation mark 4 is located, as in this example, next to the rim and central with the written characters, as shown in Figure 2, such that when the orientation mark is placed in the position needed for reading the characters, the said characters are parallel with the short side of the rectangle forming the rigid structure 1. The angle of the flat mirror 13 with respect to the plane 11 will be explained later, together with the lighting angles, with the aid of Figure 8. As shown in Figures 1 and 2, the mirror 13 and the lever arm 23 are located either side of the rigid rectangular structure 17, the lever arm 23 and the geared transmission system 27 being located on the opposite face of the rigid structure 17 to that holding the semi-conductor wafer 3. In order to ensure the proper stability of the mirror 13 with respect to vibrations, especially when in its second position, its second short side is also rigidly attached to the lever arm 23 by means of a support lug 33 passing through the rigid structure 17 to link the second short side of the mirror to the lever arm 23. If the rigid structure is intact at this point, a cut-out 34, corresponding to the path of the support lug 33 should be provided at the point where the latter passes through the rigid structure.

As we can see, the third stop roller 8, free to move in two directions within the plane 11, is thus coupled with the light ray reflector mechanism 13 such that the mechanism for moving the third stop roller 8 moves the light reflecting mechanism 13 at the same time and in both directions.

The device shown in the diagrams includes a light shield mechanism 35, to stop ambient light interfering with the characters 2 to be identified, coupled to the reflector mechanism 13 such that the reflector mechanism's 13 motion mechanism 14 moves the light shield mechanism at the same time. In practice, one difficulty with identifying the characters written on wafers is that of overcoming interference from the ambient light in the area of the device 1, especially where the characters are illuminated from the same side as the dedicated lighting. As an advantage, the mirror 13 carries a shield 35 to counter light interference on its face opposite the face used to reflect the dedicated lighting such that this shield blocks, to a large extent, any ambient light interference illuminating the characters to be identified and thus forms an area of shadow over the characters. To this end, the shield 35 consists of the opaque face of the mirror 13 on the other side of the reflecting surface. The coupling of the shield mechanism with the reflector mechanism means that the movement of one mechanism moves them both at the same time.

Note that, as an advantage, the rigid arm 5 bears two additional supports in the form of two fixed stops 36 located more or less at the ends of the second short side of the rigid structure 17 as shown in Figures 1 and 2. The stops 36 are used to support the lower edge of the wafer's rim before pressure is applied on it between the three stops 6, 7 and 8. To this end, the

... stops 36 each have a lower truncated cone section on which the lower edge of the wafer can rest and a central part that may be used to guide the wafer onto the lower truncated cone part during the Z-axis motion of the arm used to locate the wafer between the three stop rollers.

- The lighting mechanism 15 for the characters 2 written on the semi-conductor wafer 3 includes at least one known form of dedicated light beam emitted by one or more light emitting diodes 37, as shown in Figure 2, eg, a red light beam, in order to distinguish it from the ambient light. The light source for illuminating the characters includes several
- 1) light emitting diodes 37 sending out light rays 57 in one direction 59, more or less parallel to the plane 11 passing through the stops 6, 7 and 8. The diodes are attached rigidly to the rigid structure 17 behind the short side of the rectangle forming this structure as shown in Figure 2. As shown in Figure 8, the light rays 57, emitted by the diodes 37, are reflected from the reflecting surface of the mirror 13 whilst this latter is in its second position as
 - 1) described above, this second position being defined such that the light rays 57, emitted by the diodes 37, are reflected off the characters 2 on the wafer 3. The rays 58 reflected from the mirror and striking the characters 2 are again reflected from these latter to enter the reading mechanism 16 consisting of a camera 38 sensitised to the wavelength of the light rays used by the diodes 37 and attached, as with the lighting mechanism 15, rigidly to the
 - 2) rigid structure 17 behind the short side of the rectangle forming this structure, as shown in Figure 2. As a result, as shown in Figure 8, the mirror 13 in its second position has to be located on the other side of the characters 2, towards the front of the arm 5, such that the reflected rays 58 fall back onto the characters 2 situated behind it and then reflect off these latter in the rearwards direction 60 to strike the reading mechanism located in the area from
 - 2) which the light rays were originally emitted. To this end, the reflecting surface 61 of the mirror 13 needs to lie at an angle α with respect to the plane 11, inclined at greater than 45° . Such a lighting and reading layout allows the lighting and reading mechanisms to be attached to the same short side of the rectangle formed by the rigid structure 17, whilst leaving the rigid structure free to slide between two semi-conductor wafers 3 and 3A
 - 3) located one next to the other in their housing, as shown in Figure 4.

- The device includes some system (not shown) of identifying the characters based on the image as read and transmitted to this system by the reading camera 38, using some known method, especially an identification system using image processing software and a
- 3) neural networking character recognition software. As an advantage, image processing software would allow the transmitted image to be pre-processed whilst, as another advantage, neural networking character recognition software would allow an operator to visualise and identify the characters, eg, by means of monitor (not shown). Alternatively, the character identification function might be realised by means of an electronic circuit
 - 4) including a neural processor

... of the Zero Instruction Set Computer (ZISC) type.

As a further advantage, the device shown in Figures 1 to 5 includes some positioning mechanism 45 used to position the arm 5 in the immediate vicinity of a semi-conductor wafer located in the semi-conductor wafer housing. The positioning mechanism 45 consists of two sensors 46 and 47 using the principle of reflected light and each consisting of an emitter 52 and a receiver 53 for the light rays in a similar fashion to that used by the sensors 40, 41 and 42 described earlier. The arrangement of the emitter 52 and receiver 53, however, and the light rays falling on the sensors 46, 47 may differ from that used with the detectors 40, 41 and 42, as explained below.

As an advantage, the two detectors 46 and 47 are located more or less at the two ends of the first short side 50 of the rigid structure 17 in the area next to the stop rollers 22, as shown in Figures 1 to 3. The purpose of the two sensors 46 and 47 is to detect the position of the wafer whose characters are to be identified and whose dimensions are known, especially its diameter, in order to control the movement of the arm into its appropriate position in order to pick-up the wafer. In this way, each of the sensors provides a positioning point for the wafer that, together with the additional knowledge of its diameter, may be used to determine the exact position of the wafer within its housing such that the arm can then position itself in exactly the right position immediately next door to the wafer in its housing container. Both of the sensors 46 and 47 therefore include an emitter 52 of at least one light beam 54, angled in the direction 56 of the arm's 5 motion, facing forwards, as shown in Figure 6. A receiver 53 for the light beam emitted by the emitter 52 is located in front of the latter such that it receives the light beam reflected by the wafer 3 when this latter breaks the beam during the arm's motion, as shown in Figure 6. When the receiver 53 of the first sensor, whether 46 or 47, receives the light beam reflected by the wafer, the control unit (not shown) registers this and thus defines the wafer's initial positioning point. When the receiver 53 of the second receiver, whether 46 or 47, also sees the beam reflected by the wafer, the control unit (not shown) then registers this too and thus identifies the wafer's second positioning point. Using these two positioning points and knowing the wafer's diameter, the control unit can command the movement of the pick-up arm in at least the initial Y-axis direction so as to locate the arm immediately next to the semi-conductor wafer that the control unit has just located within the semi-conductor wafers' housing. Based on a knowledge of the wafer's position and the relative position of the arm, the initial movement of the arm into the neighbourhood of the wafer may be carried out by a combination of motions in the X and Y-axes. Subsequently, the control unit commands the pick-up arm's motion mechanism in a second, Z-axis, direction in order to place the semi-conductor wafer between the three stop rollers 6, 7 and 8, and in contact with the fixed stops 36 and the lower lips of the stop rollers 6 and 7 in such a way as to allow the subsequent seating

... of the pick-up arm's three stop rollers 6, 7 and 8 against the rim of the semi-conductor wafer by a movement of the moving stop roller 8 as explained above.

As a further advantage, the invention's device includes some means (not shown) to move the pick-up arm through space in the three axes, X, Y and Z. To this end, the pick-up arm described earlier and shown in Figures 1 to 3 is rigidly attached in any known manner to an arm support mechanism (not shown) free to move in the three directions, X, Y and Z in space, eg, at right angles to one another.

- 1) The central control unit (not shown) for the device shown in the diagrams is used to coordinate the control of the moving stop roller's 8 rotation and the associated movement of this stop 8 and its associated mirror 13 in the plane 11 as described above. It also coordinates the functions of the lighting mechanism 15, the active sensors 40, 41, 42, 46 and 47, the character reading and identification mechanism 38 and the arm's motion mechanism in accordance with a requirement-driven character identification procedure as described above.

- 2) We shall now describe one example of the invention's procedure that might be implemented by the invention's device as described above. The identification procedure for the characters 2 written on a semi-conductor wafer with one orientation mark 4 consists of the following stages:

- 25 - Inserting the pick-up arm 5 with its three stop rollers 6, 7 and 8 in the immediate vicinity of a semi-conductor wafer 3, stored horizontally in a semi-conductor wafer housing (not shown), by means of an initial combined arm movement in the first (Y-axis) and third (X-axis) directions at right angles to one another, the said first Y-axis and third X-axis defining the plane of motion between two successive horizontal wafers in the wafer housing.
- 30 - Locating the semi-conductor wafer 3 between the three stop rollers 6, 7 and 8 by means of a second movement of the arm in the second (Z-axis) direction, at right angles to the plane defined by the X and Y axes, such that the wafer seats on the lower lips of the stop rollers 6 and 7 and against the fixed stops 36 by the lower edge of the wafer's rim.
- 35 - Bringing the three stop rollers 6, 7 and 8 on the pick-up arm 5 into contact with the rim 9 of the semi-conductor wafer 3 by means of an initial movement of the moving stop 8 in the plane 11, parallel with the wafer.
- 40 - At the same time as the initial movement of the moving stop 8, the reflector mechanism 13 for the dedicated light beam is moved to the area 62 more or less alongside and above the place where the characters 2 will be after the wafer's orientation, ie, in the area 62 used for the transmission of the dedicated light rays onto the characters but on the other side of the area where these characters will appear and on the far side of their position on the wafer 3.
- 45 - Locating the light shield mechanism 35 to protect the characters to be identified from

... ambient light interference at the same time as the reflector mechanism 13 is moved into the space 62 more or less next to and above the place where the characters 2 will appear after the wafer's orientation.

- 1 - Orienting the semi-conductor wafer 3, once gripped, by means of rotating the stop roller 8 around its spindle so as to place the orientation mark 4 in a predetermined position in which the lighting mechanism can illuminate the characters to be identified.
- 10 - Illuminating the characters 2 to be identified by means of a dedicated light beam reflected by the reflector mechanism 13 onto the characters to be identified.
- 15 - Reading the characters to be identified by means of the light rays reflected from the characters and using a camera sensitised to the wavelength of the dedicated light beam's rays.
- 20 - Identifying the characters from the image supplied by the camera.
- 25 - Releasing the semi-conductor wafer 3 from the grip of the three stop rollers 6, 7 and 8 by moving the mobile stop 8 in the opposite direction to its initial movement, the one that brought it into contact with the rim of the wafer 3, whilst, at the same time, withdrawing the reflector mechanism 13 from the space 62 more or less alongside and above the characters. The arm 5 is then free to move in the opposite direction to its second movement in the Z-axis.
- 30 - Removing the semi-conductor wafer 3 from the pick-up arm 5 by means of a third movement of the arm in a third direction opposite to the second (Z-axis) direction such that the wafer again rests in its housing.
- 35 - Withdrawing the pick-up arm from the immediate vicinity of the wafer 3 by means of a fourth movement of the arm in a fourth direction opposite to the first (Y-axis) direction.

The procedure may also make use of the pick-up arm 5 to include a movement through space of the semi-conductor wafer, eg, to a second housing other than that from which the wafer was originally selected, either after identification of the wafer's 3 characters but before releasing it, or whilst carrying out one of the steps consisting of orienting, illuminating or reading the wafer and identifying the characters.

CLAIMS

- 5 1. A procedure to identify characters 3 written on a semi-conductor wafer 2 with at least one orientation mark 4, *identifiable in that* it includes the following stages:
 - Gripping the semi-conductor wafer by gripping its rim 9 between at least three stop rollers 6, 7, 8 on a pick-up arm 5,
 - 10 - Orienting the semi-conductor wafer, once gripped, by rotating at least one 8 of the at least three stop rollers in such a way as to place the orientation mark in a pre-determined position,
 - Positioning the dedicated light ray reflector mechanism 13 within a space 62 approximately alongside and above the characters 2 to be identified on the gripped and orientated wafer,
 - 15 - Illuminating the characters to be identified on the gripped and orientated wafer by means of a dedicated light beam 57, reflected by the said reflector mechanism 13, onto the characters to be identified,
 - 20 - Reading the characters to be identified on the gripped and orientated wafer by means of the light rays reflected by the characters,
 - Identifying the characters 2.
- 25 2. A procedure as claimed in Claim 1, *identifiable in that* it consists of gripping the semi-conductor wafer 3 by seating its rim 9 between at least three stop rollers 6, 7 and 8 and, at the same time, positioning the light ray reflector mechanism 13 in the space 62 more or less alongside and above the place where the characters 2 will appear after orientation of the wafer.
- 30 3. A procedure as claimed in Claims 1 or 2, *identifiable in that* it also includes a light shield mechanism 35 to protect against ambient light interfering with the characters to be identified and that is located at the same time as the reflector mechanism 13 in the space 62.
- 35 4. A procedure as claimed in any of the Claims 1 to 3, *identifiable in that* it also allows for the movement of the semi-conductor wafer 3 through space, either after identifying the characters 2 or whilst carrying out one of the stages in which the semi-conductor wafer is oriented or in which the characters are illuminated, read or identified.
- 40 5. A procedure as claimed in any of the Claims 1 to 4, *identifiable in that* the said stage grips the semi-conductor wafer 3 by gripping its rim 9 between at least three stop rollers 6, 7, 8 connected to a pick-up arm 5, the stage consisting of the following steps:
 - Inserting the pick-up arm with its at least three stop rollers into the immediate vicinity of a semi-conductor wafer 3 positioned in a semi-conductor wafer housing by means of an initial
 - 45 movement of the pick-up arm in at least one initial Y-axis direction,
 - Locating the semi-conductor wafer 3 between the at least three stop rollers 6, 7, 8 by means of a second arm motion in a second (Z-axis) direction

... in space.

- Bringing the at least three stop rollers on the pick-up arm into contact with the rim of the semi-conductor wafer.

After having identified the characters, the said procedure also includes the following steps:

- Removing the reflector mechanism 13 from the area 62 more or less alongside and above the characters 2.

1)

- Releasing the semi-conductor wafer 3 from the grip of the at least three stop rollers 6, 7, 8.

- Removing the semi-conductor wafer 3 from the pick-up arm 5 by means of a third arm motion in a third direction, opposite to the second direction, in the Z-axis.

1)

- Withdrawing the pick-up arm 5 from the immediate vicinity of the wafer by means of a fourth arm motion in a fourth direction opposite to that of the initial direction, in the Y-axis.

2)

6. A device for the identification of the characters 2 written on a semi-conductor wafer 3 with at least one orientation mark 4 allowing the use of the procedure in Claim 1, *identifiable in that* it includes:

2)

- A rigid pick-up arm 5 with, in a fixed plane 11, at least one first 6 and one second 7 stop roller, each free to rotate at least about their centre lines, and one third stop roller free to rotate at least around its own centre line and also free to move within the fixed plane 11, the said first, second and third stop rollers being used to grip one semi-conductor wafer by its rim 9.

3)

- A motion mechanism 10 for the third stop roller 8 within the fixed plane 11.

- An orientation mechanism for the semi-conductor wafer, consisting of a rotary drive mechanism 12 using at least one of the first 6, second 7 or third 8 stop rollers.

3)

- A reflector mechanism 13 for the light rays.

- A motion mechanism 14 for the reflector mechanism 13.

- An illumination mechanism 15 for the characters, consisting of at least one light beam.

4)

- A mechanism for reading 16 the characters.

- An mechanism for identifying the characters.

4)

7. A device as claimed in Claim 6 allowing the use of the procedure in Claim 2, *identifiable in that* the third stop roller 8, free to move within the fixed plane 11, is coupled to the light ray reflector mechanism 13 such that the motion mechanism 10 for the third stop roller 8 moves the light ray reflector mechanism 13 in both directions.

8. A device as claimed in the Claims 6 or 7 allowing the use of the procedure in Claim 3, *identifiable in that* it includes some form of light shield 35 to protect against ambient light interfering with the characters to be identified and coupled with the reflector mechanism 13 such that the reflector mechanism's motion mechanism may be used to move the light shield mechanism at the same time.

9. A device as claimed in the Claims 6 to 8 allowing the use of the procedure in Claims 4 or 5, *identifiable in that* it also includes some mechanism to move the pick-up arm through space.

A device as claimed in Claim 9, *identifiable in that* the said motion mechanism for the pick-up arm in space consists of at least:

- A mechanism to move the said pick-up arm through its initial direction in the Y-axis, and back again,

- A mechanism to move the said pick-up arm through its second direction in the Z-axis, and back again,

- A mechanism to move the said pick-up arm through its third direction in the X-axis, and back again.