DESCRIPTION

TITLE: Multistage Chemical Mechanical Polishing Process Applied To Materials Of The Semiconductor Industry

TECHNICAL FIELD OF THE INVENTION

The invention relates to an optimized chemical mechanical polishing process for reducing the generation of scratches on substrates such as substrates of semiconductor materials, known as wafers.

TECHNOLOGICAL BACKGROUND

The field of semiconductor materials requires that material surfaces which are extremely flat and even be obtained, for example in order to prepare a wafer of semiconductor material for a photolithography stage or a stage of direct contact bonding, or in order to work the surface of a donor wafer or a layer separated from such a wafer after a splitting stage, possibly using Smart Cut™ technology. For these purposes, operations of mechanical or chemical mechanical polishings of surfaces (CMP) are commonly employed.

Chemical mechanical polishing is a process for the smoothing of surfaces combining mechanical and chemical actions. During an operation of chemical mechanical polishing of a wafer, the latter is pressed and rubbed against a polishing pad in the presence of a polishing solution, commonly known as slurry. During a mechanical polishing, the slurry is chemically neutral and does not chemically attack the material to be polished.

The polishing pad generally consists of a flexible disc made of polymer or woven or non-woven fabric, of known roughness, and exhibiting a profile making possible the abrasion of the surface of the wafer. The polishing solution consists of a liquid capable of chemically etching the wafer, for example by oxidation, and

containing abrasive particles capable of mechanically etching the material.

In parallel with the polishing of a wafer, the polishing pad can be frictionally conditioned by means of a conditioner element, consisting for example of a metal disc having diamonds inlaid at its surface.

Patent document US 2006/0183410 A1 relates to a system and process for diamond conditioning of soft polishing pads for chemical mechanical planarization and polishing (CMP).

Patent document US 2011/0256812 A1 relates to closed-loop control for improving the profiles of polishing pads.

Patent document US 8,562,392 B2 relates to a polishing apparatus and polishing method.

Patent document US 2003/0166383 A1 relates to a polishing apparatus.

Patent document US 2017/0008146 A1 relates to a chemical-mechanical planarization conditioner.

Patent document US 5,961,373 A relates to a process for fabricating a semiconductor device including the conditioning of a polishing pad.

A specific example for which extremely fine preparation of the surfaces is required is that of the preparation of silicon carbide SiC slabs, for the purpose of providing atomically flat and damage-free substrates for the purpose of high-quality epitaxy. These substrates are fundamental components in the manufacture of high-performance semiconductor devices for high-power applications.

CMP operations involve mechanical abrasion and thus the generation of debris which can aggravate certain defects of surfaces, such as scratches. It may become necessary to remove this debris in order to ensure polishing of the targeted quality. More generally, in order to avoid the appearance of surface defects or to reduce these defects, CMP operations are usually

carried out while finely adjusting the polishing parameters and while carefully choosing the consumables employed. In spite of everything, there still remains room for improvement, which it is desirable to make use of in view of the importance of the surface quality of the substrates or the layers in the semiconductor industry.

To this end, two-stage CMP polishing processes have been developed, as explained, for example, by Weilei Wang *et al.* in the paper "Two-Step Chemical Mechanical Polishing of 4H-SiC (0001) Wafer", 2021, ECS J. Solid State Sci. Technol., 10.074004. CMP operations bring into play complex interactions between the surface of the wafers and the consumables of the item of CMP equipment (polishing pad, slurry, element for conditioning the polishing pad). The two-stage process then consists in using a first combination of consumables in a first stage to achieve a first objective, such as a high rate of removal of matter from the surface of the wafer to be processed. In a second stage, a second combination of consumables is employed in order to achieve a second objective, such as high surface quality of the wafer. On the other hand, the slurry/polishing pad pair changes between the first stage and the second stage. This approach complicates the choice of the consumables and increases the number of operations to be carried out, in an industrial context where, on the contrary, the simplification of the operations while maintaining a desired performance level is sought.

SUMMARY OF THE INVENTION

An object of the invention is to provide a process for the mechanical or chemical mechanical polishing of substrates employed in the semiconductor industry which solves the abovementioned problems.

For the purpose of achieving these objects, one aspect of the invention is a process for the polishing of a flat substrate by means of a planarization and polishing machine comprising a support plate on which an interchangeable polishing pad is placed, an interchangeable conditioning head provided for conditioning the polishing pad, and a polishing head provided for holding the flat substrate against the interchangeable polishing pad, the process comprising three stages: (1) a first stage in which a first conditioning of a first polishing pad by means of a first conditioning head is carried out, the flat substrate not being subjected to an operation of polishing against the polishing pad during this first stage; (2) a second stage following the first stage, in which a first polishing of the flat substrate is carried out, the flat substrate being held against the first polishing pad by means of the polishing head, and the first polishing pad not being subjected to a conditioning operation during this second stage; and (3) a third stage following the second stage, in which (i) a second polishing of the flat substrate is carried out by holding the flat substrate against a second polishing pad by means of the polishing head and, simultaneously, (ii) a second conditioning of the second polishing pad is carried out by means of a second conditioning head.

The polishing process according to the invention makes it possible to reduce the presence of scratches at the surface of flat substrates, and also to obtain a surface state compatible with subsequent operations which are demanding with regard to this surface state, such as photolithography or epitaxial growth operations, for the purpose of manufacturing electronic circuits.

In addition, this leads to a simplification of the management of the consumables (polishing pad, conditioning head, polishing solution) employed during the polishing and to a reduction in

the number of handling operations involved by making it possible to use the same consumables throughout the polishing operation, without being obliged to change these consumables between the stages of the process.

According to additional non-limiting characteristics of the invention, considered individually or according to any technically achievable combination:

- the first polishing pad and the second polishing pad can be one and the same polishing pad;
- one and the same polishing solution can be led onto the plate during the first stage, the second stage and the third stage;
- the first conditioning head and the second conditioning head can be one and the same conditioning head;
- a parameter representative of a force applied to the flat substrate by the polishing head can be the same for the second stage and the third stage;
- a parameter representative of a rotation applied to the flat substrate by the polishing head can be the same for the second stage and the third stage;
- a parameter representative of a rotation applied to the plate can be the same for the second stage and the third stage; and
- the flat substrate can consist of a silicon carbide plate or comprise a silicon carbide layer to which the chemical mechanical polishing is applied.

The invention applies to a process for the manufacture of a composite substrate comprising the stages of preparing a surface of a donor substrate; preparing a surface of a recipient substrate; assembling the recipient substrate with the donor substrate by bringing the prepared surface of the donor substrate into direct contact with the prepared surface of the recipient substrate; splitting the donor substrate so as to leave, on the

recipient substrate, a transfer layer formed of a certain thickness of the donor substrate; and preparing a free surface of the transfer layer, in which at least one of the stages of preparing the surface of the donor substrate, preparing the surface of the recipient substrate and preparing the free surface of the transfer layer is carried out by means of the polishing process according to the invention.

According to additional non-limiting characteristics of the invention, considered individually or according to any technically achievable combination:

- the donor substrate can be at least partially formed of SiC or of GaN, each of single-crystal structure, and/or wherein the recipient substrate can be at least partially formed of SiC or of AlN, each in polycrystalline form;
- the process for the manufacture of a composite substrate can additionally comprise a stage of reconditioning a free surface of the donor substrate after the splitting stage, in which the reconditioning stage is carried out by means of the polishing process according to the invention.

The invention applies to a process for the manufacture of an electronic device, comprising a stage chosen from epitaxial layer growth, a stage of direct contact bonding or a photolithography operation carried out on the flat substrate which has been subjected to the polishing process according to the invention.

BRIEF DESCRIPTION OF THE FIGURES

Other characteristics and advantages of the invention will become apparent from the detailed description of the invention which will follow, with reference to the appended figures, in which:

[Fig. 1] Figure 1 illustrates a planarization and polishing machine during use;

[Fig. 2] Figure 2 illustrates a chemical mechanical polishing process according to the invention;

[Fig. 3] Figure 3 illustrates results of tests of a chemical mechanical polishing process with "*in situ*" conditioning;

[Fig. 4] Figure 4 illustrates results of tests of a chemical mechanical polishing process with "*ex situ*" conditioning;

[Fig. 5] Figure 5 illustrates results of tests of a three-stage chemical mechanical polishing process according to the invention;

[Fig. 6] Figure 6 illustrates the manufacture of a composite substrate employing the polishing process of figure 2;

[Fig. 7] Figure 7 illustrates the process for the manufacture of a composite substrate of figure 6.

DETAILED DESCRIPTION OF THE INVENTION

Embodiment of the invention

An embodiment of the invention is described in detail below and illustrated by figures 1 to 5.

In the continuation of this description, the invention will be described in the example of a chemical mechanical polishing. However, it should be noted that the invention is also applicable to purely mechanical polishing operations.

Figure 1 illustrates a machine Mac for chemical mechanical polishing during use, with a support plate Pl on which an interchangeable polishing pad Pol.Pad is placed, an interchangeable conditioning head Cond.Head provided for conditioning the polishing pad Pad.Pol, and a polishing head Pol.Head provided for holding a substrate to be treated against the polishing pad.

The operation of polishing a flat substrate Waf, such as a wafer, takes place by holding the wafer against the polishing pad Pol.Pad via the polishing head Pol.Head by applying to it a force F1 directed towards the plate Pl and a rotation ω2 about a vertical axis Ax2 centred on the polishing head. The rotation ω2 is transmitted to the wafer by means of a carrier element Car in contact with the wafer.

The plate Pl additionally follows a rotation ω1 along a vertical axis Ax1 centred on the plate. The relative movements of the plate and of the wafer make possible even polishing.

Although not represented here, the polishing machine Mac is equipped with a system for dispensing a polishing solution Sl, which plays the roles of lubrication and of chemical etching of the surface of the wafer.

The polishing machine Mac is also equipped with a head Cond.Head for conditioning the polishing pad Pol.Pad. Its role is to condition the surface of this pad in order to keep its characteristics stable. The conditioning head can consist of a rigid metal disc having the surface inlaid with diamonds. The disc is in rotation ω3 about an axis Ax3 centred on the conditioning head, the latter being mounted at the end of an arm Sw.Ar in oscillatory movement Sw about an axis A4 centred on the other end of the arm Sw.Ar. A vertical force F2 oriented towards the plate Pl is applied to the conditioning head.

Figures 3, 4 and 5 illustrate results of characterization of flat substrates exhibiting at least one silicon carbide surface which has been subjected to, respectively, (1) polishing of the wafer with concomitant conditioning of the polishing pad (referred to as polishing with "*in situ*" conditioning), (2) polishing of the wafer following conditioning of the polishing pad, without conditioning concomitant with the polishing (referred to as polishing with "*ex situ*" conditioning), and (3) a first polishing of the wafer following conditioning of the

polishing pad, without conditioning concomitant with the polishing (thus, conditioning referred to as "*ex situ*"), and a second polishing of the wafer with concomitant conditioning of the polishing pad (referred to as polishing with "*in situ*" conditioning).

The relevant parameters for the polishing operations mentioned in the preceding paragraph are as follows.

The conditioning pad can have a hardness of between 90 and 100 Shore A, a compressibility of between 0% and 6%, a density of between 0.95 and 1.11, and be driven in rotation ω1 at a speed of between 90 and 120 revolutions/min.

The polishing head can impose, on the wafer, a pressure of between 3 and 9 psi (unit conventionally used in this field by suppliers of this type of equipment), i.e. between 21 000 and 62 000 N/m^2, and be driven in rotation ω2 at a speed of between 70 and 160 revolutions/min.

The conditioning head can consist of a diamond-coated metal disc with an aggressiveness of between 20 and 30, with a flatness of between 0 and 75, with a rotational speed ω3 of between 10 and 140 revolutions/min, and be configured to apply a force, to the polishing pad, of between 4 and 8 lbf (pound-force, unit conventionally used by suppliers of this type of equipment), assuming that the standard diameter of the conditioning head is 4.25 inches (unit conventionally used by suppliers of this type of equipment).

The characterization illustrated here was carried out by an SICA88 apparatus from Lasertec, which makes it possible to combine visible light Nomarski prism confocal microscopy and photoluminescence techniques (as described by [1] T. Kimoto *et al.*, “Fundamentals of Silicon Carbide Technology Growth Characterization Devices and Applications”, p. 126, or [2] D. Baierhofer *et al.*, “Materials Science in Semiconductor

Processing", 140 (2022), 106 414) and is commonly used to inspect the surfaces of semiconductor substrates.

Defectivity charts, which reveal different types of defects of of defects of the surface analyzed, are represented in (A) of figures 1 to 3. Results of roughness analyses are represented in (B) in figures 1 to 3.

As indicated by figure 3, a conventional polishing operation involves the conditioning of the polishing pad simultaneously with the polishing of the wafer. However, this way of proceeding does not satisfactorily prevent the formation of surface defects, such as scratches.

The interpretations of figures 1 to 4 are as follows. A stage of polishing of wafers with concomitant conditioning of the polishing pad generates a variable scratch rate of between 10% and 30%, which means that from 10% to 30% of the wafers exhibit a scratch; see figure 3 in (A). The associated roughness, illustrated in (B) of figure 3, is within a range extending from 4 to 5 in arbitrary unit of the SICA88 apparatus, with regions R1 and R2 exhibiting roughnesses of less than 4.6 and 5.1 in arbitrary unit of the SICA88 apparatus, respectively.

As illustrated by figure 4, an "*ex situ*" polishing operation makes it possible to reduce the scratch rate to a range extending from 0% to 8%, with a roughness within a range extending from 5 to 7 in arbitrary unit of the SICA88 apparatus, with regions R1 and R2 exhibiting roughnesses of less than 5.7 and 6.3 in arbitrary unit of the SICA88 apparatus, respectively.

The mechanisms responsible for the differences in surface states between the types of polishing operations of figures 3 and 4 are not fully explained. The lower roughness of the polishing operation with "*in situ*" conditioning would be due to a good surface state of the polishing pad, the latter being continuously reconditioned. The increased roughness of the polishing operation with "*ex situ*" conditioning appears to be

related to debris from the wafer, to diamond particles from the conditioning head and/or to abrasive particles from the polishing solution. The "*ex situ*" conditioning does not make it possible to optimize the roughness but seems to make possible better evacuation of the particles or agglomerates responsible for the scratches.

Starting from this observation, it is proposed to employ a process 100 for polishing a flat substrate Waf, such as a wafer, in three main stages. The results of this process, illustrated by figure 5, will be discussed below.

In a stage 110, a first polishing pad Pol.Pad is conditioned by means of a conditioning head Cond.Head. A polishing solution Sl is led onto the first polishing pad. During this first stage, the flat substrate Waf is not subjected to a polishing operation against the polishing pad Pol.Pad.

In an intermediate stage 115 following the stage 110, the conditioning head is moved away from the first polishing pad and, conversely, the flat substrate is brought into contact with the first polishing pad and pressed against it by means of the polishing head Pol.Head and of the carrier element Car.

In a second stage 120 following the intermediate stage 115, the flat substrate Waf is polished by holding it against the first polishing pad Pad.Pol by means of the polishing head Pol.Head. A polishing solution Sl is led onto the polishing pad. During this second stage, the first polishing pad Pad.Pol is not subjected to a conditioning operation. In other words, during the second stage 120 of polishing the flat substrate Waf, the conditioning head is at a distance from the polishing pad, at least a gap being maintained between the conditioning head and the polishing pad, that is to say that the head is positioned so as not to apply an action, and in particular a mechanical action, to the polishing pad. The head can also be completely removed from the polishing system, as illustrated by figure 2.

In an intermediate stage 125 following the stage 120, the conditioning head is brought into contact with the polishing pad and pressed against the latter.

In a third stage 130 following the intermediate stage 125, the flat substrate Waf is polished by holding the flat substrate Waf against the first or second polishing pad Pad.Pol by means of the polishing head Pol.Head and, simultaneously, the polishing pad Pol.Pad is conditioned by means of the conditioning head Cond.Head. A polishing solution Sl is led onto the polishing pad.

A first polishing pad is used during the stages 110 and 120. This same first polishing pad can be used for the stage 130 or else it can be replaced by a second polishing pad, of the same type as or of a different type from the first polishing pad.

One and the same conditioning head can be employed for two or three of the three stages 110, 120 and 130, or three conditioning heads of three different types can each be employed for the respective one of the three stages 110, 120 and 130.

One and the same polishing liquid can be employed for two or three of the three stages 110, 120 and 130, or three polishing liquids of three different types can each be employed for the respective one of the three stages 110, 120 and 130. As mentioned above, each polishing liquid (or solution) is liable to be either chemically neutral for the surface to be polished or capable of chemically etching the latter, as the case may be. Embodiments in which either of the stages 120 and 130 is a chemical mechanical polishing stage while the other is a mechanical polishing stage, for example, can be envisaged.

Polishing parameters, such as the speeds of the rotations $\omega 1$, $\omega 2$, $\omega 3$ and $\omega 4$, and quantities representative of the applied forces F1 and F2, can individually be the same for two or three

of the three stages 110, 120 and 130, or can be different for each of the three stages 110, 120 and 130.

Choosing consumables - polishing pads, conditioning heads, polishing liquid - which are distinct according to the stages makes possible an optimization of each of these stages and thus an optimal surface quality. On the other hand, in an industrial context, this makes the management of the consumables, the use of the polishing system (machine, stocks and handling of the consumables, and the like) and its maintenance complex and a source of errors and of additional costs.

Conversely, limiting the variations in the consumables makes possible simplified management of these consumables, and also simplifies the maintenance of the polishing system and limits the number of handling operations required, reducing the sources of errors and reducing the costs.

Figure 5 illustrates the results of three-stage polishing operations in which the consumables remain the same during the three stages 110, 120 and 130.

It is apparent that the number of scratches is reduced compared with the polishing operations illustrated by figures 3 and 4 and that the level of roughness is reduced compared with the polishing operations illustrated by figure 4, with regions R1 and R2 exhibiting roughnesses of less than 5.1 and 5.7 in arbitrary unit of the SICA88 apparatus, respectively. Thus, the number of surface defects, in particular the number of scratches, and also the roughness are compatible with subsequent epitaxy, direct bonding or photolithography operations. The three-stage polishing process according to the invention makes possible a substantial reduction in the number of surface defects compared with conventional processes.

In practice, the stage 120 can be used to remove a relatively large thickness of the flat substrate to be treated, for example between 180 nm, for substrates consisting of flat

substrates comprising a silicon carbide SiC layer, and 800 nm, for single-crystal silicon carbide wafers. This stage, with an "*ex situ*" conditioning, makes it possible to prevent the formation of scratches but leads to a non-optimal roughness.

The stage 130 can be considered as a finishing step, with an "*in situ*" conditioning, removing a smaller thickness of the flat substrate to be treated than the stage 120, approximately 50 nm, for example. This stage makes it possible to reduce the roughness of the surface of the flat substrate without introducing scratches.

Following stages 110 to 130, the flat substrate is ready to be subjected to additional operations 140 for the purpose of the manufacture of a semiconductor device. These operations can comprise one or more operations of epitaxial thin layer growth, of direct contact bonding or of photolithography.

Epitaxial thin layer growth makes it possible to obtain a semiconductor layer of high crystalline quality formed directly on the polished layer of the flat substrate.

Direct contact bonding makes it possible to combine a flat structure, which is homogeneous or complex, with the flat substrate according to known assembling methods, such as molecular bonding or bonding or metal-metal bonding.

A photolithography operation makes it possible, on the basis of the flat substrate, to produce complex semiconductor devices.

Each of these operations benefits from the polishing quality obtained by means of the process of stages 110 to 130, which makes possible an increase in the yield of the production of the final semiconductor device.

Applicative example

Figures 6 and 7 illustrate a process 200, which is a particular example of application of the process described above, particularly suitable for obtaining composite

semiconductor substrates comprising a thin layer of a first semiconductor material supported by a substrate of a second material. The thin layer is intended to form the active layer of a semiconductor device. The substrate is chosen for its characteristics, which are complementary to those of the thin layer. It is thus possible to form composite substrates formed of a layer of SiC or of GaN of single-crystal structure supported by a substrate of SiC or of AlN of polycrystalline structure.

The process 200 begins with the provision of two substrates Sub1 and Sub2 with two provisioning stages 210 and 220, respectively. In an implementational example of the invention, the substrate Sub1 consists of SiC or of GaN of single-crystal structure, and is intended to serve as donor substrate to form a thin single-crystal layer TrLay. The substrate Sub2 consists of SiC or of AlN of polycrystalline structure and is intended to serve as support substrate for the transfer layer TrLay.

In a stage 230 of implantation of at least one light entity, the substrate Sub1 is prepared for a stage of separation of the layer TrLay resulting from a part of the thickness of the substrate Sub1, according to the Smart Cut™ technology in the present example.

To this end, the substrate Sub1 must be prepared by introduction of at least one light entity, such as hydrogen or helium, into this substrate. This introduction can correspond to a hydrogen implantation, that is to say an ionic bombardment of hydrogen. In a way known per se, and as illustrated by figure 6, the hydrogen ions H^+ are implanted so as to form a weakened plane Frgl delimiting the layer TrLay to be transferred, corresponding to the volume included between the weakened plane Frgl and the surface Surf1 of the substrate Sub1 through which the H^+ ions have been implanted in the substrate Sub1.

The nature and the dose of the implanted entities and the implantation energy are chosen as a function of the thickness of

the layer which it is desired to transfer and of the physicochemical properties of the substrate Sub1. In the case of a substrate Sub1 made of SiC, it will be possible to choose to implant a dose of hydrogen of between 10^{16} and 5.10^{17} at/cm^2 with an energy level of between 30 and 300 keV in order to delimit a layer TrLay of the order of 200 to 2000 nm in thickness.

In an assembling stage 250, the two substrates Sub1 and Sub2 are assembled together by bringing the layer TrLay into direct contact with one face of the substrate Sub2. These two layers adhere to each other by molecular bonding. In this way, an intermediate stack IntStck is formed which comprises the two substrates Sub1 and Sub2 with the weakened layer Frgl.

The assembling stage requires that the surfaces brought into contact be as flat and smooth as possible, ideally atomically flat. To this end, the stages 210 and 220 of providing the substrates each comprise the implementation of the polishing process described above, applied at least to the faces of the substrates Sub1 and Sub2 intended to come into contact with each other during the assembling stage 250.

In a detachment stage S260 following the assembling stage 250, the substrate Sub1 is split into two parts at the weakened layer Frgl, according to the Smart Cut™ process in the present example. Thus, a part of the substrate Sub1 is detached from the remainder of its volume in order to isolate a layer of interest, in this instance the layer TrLay, which is detached from the remainder of the substrate Sub1 by fracturing at the weakened plane Frgl. The layer TrLay is thus transferred onto the support Sub2. The assembly obtained forms the composite substrate Comp.Sub.

This detachment stage can comprise the application, to the stack IntStck, of a heat treatment in a temperature range of the order of 800°C to 1000°C in order to make possible the detachment of the layer TrLay and thus to complete the transfer of the

latter onto the substrate Sub2. Instead of or in addition to the heat treatment, this stage can comprise the application of a blade or a jet of gaseous or liquid fluid, or of any other force of mechanical nature, at the weakened plane Frgl.

At an optional stage following the detachment stage, a stabilizing heat treatment can be applied to the composite substrate Comp.Sub. The stabilizing heat treatment makes it possible to correct crystal defects present in the layer TrLay. This heat treatment can be provided in order to bring the composite substrate to a temperature of between 1500°C and 1900°C for a period of time of between 30 minutes and 10 hours. This heat treatment is preferentially carried out by exposing the free face of the layer TrLay to a neutral gaseous atmosphere.

Following the detachment of the layer TrLay from the remainder of the substrate Sub1, its free surface Surf.Sep is uneven. In order to put it in a condition to undergo any operation conventionally employed in the semiconductor industry, it is necessary to prepare this surface Surf.Sep and in particular to reduce its roughness, ideally so as to render it atomically flat and smooth.

Thus, in a surface preparation stage 270, a planarization and polishing treatment is applied to the surface Surf.Sep of the layer TrLay. It can be the polishing treatment described above by means of figure 2.

After the splitting stage 260, the donor substrate Sub1 exhibits a surface Surf1′ formed by the splitting of the substrate at the weakened plane. At a stage Refurb of reconditioning the substrate Sub1 so that it can serve again as donor substrate, the surface Surf1′ can be put back in condition according to the same process as that of the stage 270.

In this document, the figures are not necessarily to scale. Some characteristics and some components may be represented exaggerated relative to other components or in a somewhat

schematic form, and some details of conventional elements may not be represented in the interest of clarity and of conciseness.

Of course, the invention is not limited to the embodiments described, and alternative embodiments can be introduced thereto without departing from the scope of the invention as defined by the claims.

CLAIMS

1. A process (100) for the polishing of a flat substrate (Waf) by means of a planarization and polishing machine comprising a support plate (Pl) on which an interchangeable polishing pad (Pol.Pad) is placed, an interchangeable conditioning head (Cond.Head) provided for conditioning the polishing pad (Pad.Pol), and a polishing head (Pol.Head) provided for holding the flat substrate (Waf) against the interchangeable polishing pad, the process comprising three stages:

- a first stage (110) in which a first conditioning of a first polishing pad (Pol.Pad) by means of a first conditioning head (Cond.Head) is carried out, the flat substrate (Waf) not being subjected to an operation of polishing against the polishing pad (Pol.Pad) during this first stage;

- a second stage (120) following the first stage (110), in which a first polishing of the flat substrate (Waf) is carried out, the flat substrate (Waf) being held against the first polishing pad (Pad.Pol) by means of the polishing head (Pol.Head), and the first polishing pad (Pad.Pol) not being subjected to a conditioning operation during this second stage; and

- a third stage (130) following the second stage (120), in which (i) a second polishing of the flat substrate (Waf) is carried out by holding the flat substrate (Waf) against a second polishing pad (Pad.Pol) by means of the polishing head (Pol.Head) and, simultaneously, (ii) a second conditioning of the second polishing pad (Pol.Pad) is carried out by means of a second conditioning head (Cond.Head).

2. The process (100) as claimed in claim 1, wherein the first polishing pad and the second polishing pad are one and the same polishing pad (Pol.Pad).

3. The process (100) as claimed in claim 1 or 2, wherein one and the same polishing solution (Sl) is led onto the plate during the first stage (110), the second stage (120) and the third stage (130).

4. The process (100) as claimed in any one of claims 1 to 3, wherein the first conditioning head and the second conditioning head are one and the same conditioning head (Cond.Head).

5. The process (100) as claimed in any one of claims 1 to 4, wherein a parameter representative of a force (F1) applied to the flat substrate by the polishing head is the same for the second stage (120) and the third stage (130).

6. The process (100) as claimed in any one of claims 1 to 5, wherein a parameter representative of a rotation (ω2) applied to the flat substrate (Waf) by the polishing head (Pol.Head) is the same for the second stage and the third stage.

7. The process (100) as claimed in any one of claims 1 to 6, wherein a parameter representative of a rotation (ω1) applied to the plate (Pl) is the same for the second stage and the third stage.

8. The process (100) as claimed in any one of claims 1 to 7, wherein the flat substrate consists of a silicon carbide plate or comprises a silicon carbide layer to which the chemical mechanical polishing is applied.

9. A process (200) for the manufacture of a composite substrate (Comp.Sub) comprising the stages of:

- preparing (210) a surface (Surf1) of a donor substrate (Sub1);
- preparing (220) a surface (Surf2) of a recipient substrate (Sub2);
- assembling (250) the recipient substrate (Sub1) with the donor substrate (Sub2) by bringing the prepared surface (Surf1) of the donor substrate into direct contact with the prepared surface (Surf2) of the recipient substrate;
- splitting (260) the donor substrate (Sub1) so as to leave, on the recipient substrate (Sub2), a transfer layer (TrLay) formed of a certain thickness of the donor substrate (Sub1); and
- preparing (270) a free surface (Surf.Sep) of the transfer layer,

wherein at least one of the stages of preparing the surface (Surf1) of the donor substrate, preparing the surface (Surf2) of the recipient substrate and preparing the free surface (SepSurf) of the transfer layer is carried out by means of the process of any one of claims 1 to 8.

10. The process (200) as claimed in claim 9, wherein the donor substrate (Sub1) is at least partially formed of SiC or of GaN, each of single-crystal structure, and/or wherein the recipient substrate (Sub2) is at least partially formed of SiC or of AlN, each in polycrystalline form.

11. The process (200) as claimed in claim 9 or 10, additionally comprising a stage (Refurb) of reconditioning a free surface (Surf1') of the donor substrate (Sub1) after the splitting stage (260), wherein the reconditioning stage is carried out by means of the process of any one of claims 1 to 8.

12. A process for the manufacture of an electronic device, comprising a stage (140) chosen from epitaxial layer growth, a stage of direct contact bonding or a photolithography operation carried out on the flat substrate which has been subjected to the process as claimed in any one of claims 1 to 8.