

Another problem arises from the supply of HR substrates, which is becoming increasingly restricted, in parallel with the increase in the manufacture of RF devices. As a result, the material is becoming increasingly expensive.

SUBJECT-MATTER OF THE INVENTION

Embodiments of ~~the~~ present invention ~~proposes seek to~~ provide an alternative solution for providing a handle substrate suitable for composite structures on which high performance RF devices can be produced and for facilitating the supply and manufacturing processes.

BRIEF DESCRIPTION OF THE INVENTION

~~With a view to achieving this aim, the subject-matter~~ An aspect of the present invention ~~proposes~~ provides a handle substrate for a composite structure comprising:

- a base substrate formed of an epitaxial layer of silicon on a monocrystalline silicon wafer ~~of Cz type, i.e.~~ obtained by Czochralski pulling, having a resistivity of between 10 and 500 ohm.cm, the said epitaxial layer of silicon exhibiting a resistivity of greater than 2000 ohm.cm and a thickness ranging from 2 to 100 microns,
- a passivation layer on and in contact with the epitaxial layer of silicon, the said passivation layer being amorphous or polycrystalline,
- a charge-trapping layer on and in contact with the passivation layer,

~~According to other advantageous and non-limiting characteristics of the invention, taken individually or according to any technically achievable combination:~~

the handle substrate being characterized in that:

- the passivation layer is a layer of silicon carbide formed by carbonization of the surface of the epitaxial layer of silicon; or
- the passivation layer is a layer of silicon nitride formed by nitridation of the surface of the epitaxial layer of silicon.

Another aspect of T~~the present invention also relates to~~provides a composite structure for radiofrequency applications comprising:

- a handle substrate as above,
- a dielectric layer on and in contact with the ~~passivation layer~~charge-trapping layer,
- a thin film on the dielectric layer, suitable for radiofrequency devices.

Another aspect of T~~the present invention relates finally to~~provides a process for the formation of a handle substrate for a composite structure, the process comprising:

- a) the provision of a monocrystalline silicon wafer obtained by Czochralski pulling having a resistivity of between 10 and 500 ohm.cm;
- b) the growth of an epitaxial layer of silicon on the monocrystalline silicon wafer obtained by Czochralski pulling to form a base substrate, the said epitaxial layer of silicon exhibiting a resistivity of greater than 2000 ohm.cm and a thickness ranging from 2 to 100 microns;
- c) the formation of a passivation layer on the epitaxial layer of silicon, the said passivation layer being amorphous or polycrystalline;
- d) the growth of a polycrystalline charge-trapping layer on the passivation layer-;

~~According to other advantageous and non-limiting characteristics of the invention, taken individually or according to any technically achievable combination:~~

the process being characterised in that stage c) comprises:

- ~~stage c) comprises~~ a carbonization of the surface of the epitaxial layer of silicon, so as to form a passivation layer made of polycrystalline silicon carbide; or
- a nitridation of the surface of the epitaxial layer of silicon, so as to form a passivation layer made of silicon nitride.

According to embodiments of the present invention:

- the carbonization of stage c) comprises the exposure of the base substrate to a single carbon precursor at a pressure below atmospheric pressure in order to form a passivation layer made of polycrystalline silicon carbide of at least 5 nm in thickness on the surface of the epitaxial layer of silicon;
- the said single carbon precursor exhibits a temperature of between 700°C and 1200°C;
- ~~• stage c) comprises a nitridation of the surface of the epitaxial layer of silicon, so as to form a passivation layer made of amorphous silicon nitride;~~
- the passivation layer exhibits a thickness of at least 10 nm;
- the charge-trapping layer has a thickness of greater than 5 or 10 microns;
- the charge-trapping layer is made of polycrystalline silicon;
- stages b), c) and d) are all carried out successively *in situ* in epitaxy equipment;
- stage b) is carried out in a first reactor and stages c) and d) are carried out in a second reactor, and in which the transfer of the base substrate from the first reactor

to the second reactor is carried out without breaking the vacuum.

BRIEF DESCRIPTION OF THE DRAWINGS

CLAIMS

1. Handle substrate ~~(100)~~ for a composite structure comprising:
 - a base substrate ~~(12)~~ formed of an epitaxial layer ~~(2)~~ of silicon on a monocrystalline silicon wafer ~~(1)~~ obtained by Czochralski pulling, having a resistivity of between 10 and 500 ohm.cm, the said epitaxial layer ~~(2)~~ of silicon exhibiting a resistivity of greater than 2000 ohm.cm and a thickness ranging from 2 to 100 microns,
 - a passivation layer ~~(3)~~ on and in contact with the epitaxial layer ~~(2)~~ of silicon, the said passivation layer ~~(3)~~ being amorphous or polycrystalline,
 - a charge-trapping layer ~~(4)~~ on and in contact with the passivation layer ~~(3)~~,
 the handle substrate ~~(100)~~ being characterized in that:
 - the passivation layer ~~(3)~~ is a layer of silicon carbide formed by carbonization of the surface of the epitaxial layer ~~(2)~~ of silicon, or
 - the passivation layer ~~(3)~~ is a layer of silicon nitride formed by nitridation of the surface of the epitaxial layer ~~(2)~~ of silicon.

2. Composite structure ~~(110)~~ for radiofrequency applications comprising:
 - a handle substrate ~~(100)~~ according to the preceding claim,
 - a dielectric layer ~~(5)~~ on and in contact with the charge-trapping layer ~~(4)~~,
 - a thin film ~~(6)~~ on the dielectric layer ~~(5)~~, suitable for radiofrequency devices.

3. Process for the formation of a handle substrate ~~(100)~~ for a composite structure, the process comprising:

- a) the provision of a monocrystalline silicon wafer ~~(1)~~ obtained by Czochralski pulling having a resistivity of between 10 and 500 ohm.cm;
- b) the growth of an epitaxial layer ~~(2)~~ of silicon on the monocrystalline silicon wafer ~~(1)~~ obtained by Czochralski pulling to form a base substrate ~~(12)~~, the said epitaxial layer ~~(2)~~ of silicon exhibiting a resistivity of greater than 2000 ohm.cm and a thickness ranging from 2 to 100 microns;
- c) the formation of a passivation layer ~~(3)~~ on the epitaxial layer ~~(2)~~ of silicon, the said passivation layer ~~(3)~~ being amorphous or polycrystalline;
- d) the growth of a polycrystalline charge-trapping layer ~~(4)~~ on the passivation layer ~~(3)~~;

the process being characterized in that stage c) comprises:

- a carbonization of the surface of the epitaxial layer ~~(2)~~ of silicon, so as to form a passivation layer ~~(3)~~ made of polycrystalline silicon carbide, or
- a nitridation of the surface of the epitaxial layer ~~(2)~~ of silicon, so as to form a passivation layer ~~(3)~~ made of silicon nitride.

4. Process according to the preceding claim, in which the carbonization of stage c) comprises the exposure of the base substrate ~~(12)~~ to a single carbon precursor at a pressure below atmospheric pressure in order to form a passivation layer ~~(3)~~ of polycrystalline silicon carbide of at least 5 nm on the surface of the epitaxial layer ~~(2)~~ of silicon.

5. Process according to the preceding claim, in which the said single carbon precursor exhibits a temperature of between 700°C and 1200°C.

6. Process according to any one of Claims 3 to 5, in which the passivation layer ~~(3)~~ exhibits a thickness of at least 10 nm.
7. Process according to any one of Claims 3 to 6, in which the charge-trapping layer ~~(4)~~ has a thickness of greater than 5 or 10 microns.
8. Process according to any one of Claims 3 to 7, in which the charge-trapping layer ~~(4)~~ is made of polycrystalline silicon.
9. Process according to any one of Claims 3 to 8, in which stages b), c) and d) are all carried out successively *in situ* in epitaxy equipment.
10. Process according to the preceding claim, in which stage b) is carried out in a first reactor and stages c) and d) are carried out in a second reactor, and in which the transfer of the base substrate ~~(12)~~ from the first reactor to the second is carried out without breaking the vacuum.