Another solution is to modify the materials used to carry out the brazing, which is difficult to implement, in particular while preserving the mechanical solidity and the electrical and thermal conductivity of the brazing.

DESCRIPTION OF THE INVENTION

The present disclosure seeks to propose a composite structure for the fabrication of electronic devices, exhibiting better resistance to temperature cycles, avoiding cracks, delaminations and crumbling at the brazing interface.

An aspect of the present invention provides a method for fabricating a substrate for a radiofrequency or power electronics device, comprising

- forming a support substrate comprising deposition of at least one layer of polycrystalline silicon carbide by chemical vapor deposition, CVD, in an atmosphere comprising a mixture of argon and a deposition precursor that is fluidified in hydrogen, said chemical vapor deposition being carried out under $Ar/(Ar+H_2)$ ratio and temperature conditions suitable for forming carbon inclusions in said silicon carbide layer, and
- assembling the support substrate and a surface layer made of a monocrystalline material.

The CVD process under a gaseous atmosphere is an alternative to the known sintering process. The CVD process makes it possible to control the composition and morphology of the deposited layer. In particular, it may make it possible to create a concentration gradient of inclusions in a single deposition process.

The elongate silicon carbide grains are capable of generating an anisotropic electrical and thermal resistivity that is lower in a direction perpendicular to the surface of the substrate. This improves the removal of heat and the conduction of electricity towards the rear surface of the substrate. The presence of the carbon inclusions does not adversely affect the operation of the electronic device which is fabricated in or on the monocrystalline surface layer, which is devoid of such inclusions.

Advantageously, the deposition precursor is methyltrichlorosilane.

Preferably, the surface layer is made of a semiconductor material, preferably of silicon carbide or of gallium nitride or of diamond.

Advantageously, at least a first phase of the chemical vapor deposition is carried out at a temperature of greater than 1200°C, preferably greater than 1400°C.

Advantageously, a first chemical vapor deposition start temperature is greater than a second chemical vapor deposition end temperature.

Preferably, the $Ar/(Ar+H_2)$ ratio decreases during the chemical vapor deposition step.

Advantageously, the formation of the support substrate further comprises a step of assembling said at least one silicon carbide layer comprising the carbon inclusions with a base layer made of porous silicon carbide.

Another aspect of the present invention provides a substrate for a radiofrequency or power electronics device, comprising

- a support substrate made of polycrystalline silicon carbide having a front face and a rear face, and
- a surface layer made of monocrystalline material extending over the front face of said support substrate,

said substrate being characterized in that at least a portion of said support substrate comprises a plurality of silicon carbide grains having an elongated shape and oriented in a direction perpendicular to the surface of the substrate and a plurality of carbon inclusions located between said grains.

Preferably, the surface layer is made of a semiconductor material, preferably of silicon carbide or of gallium nitride or of diamond.

Advantageously, the ratio between the length and the width of the silicon carbide grains in the support substrate is greater than or equal to 1:1.2, advantageously greater than 1:10 and more advantageously greater than 1:20.

The ratio between the length and the width of the silicon carbide grains further facilitates polishing. Thus, if the polishing causes an elongate silicon carbide grain to be torn off in a direction perpendicular to the surface of the substrate, a cavity with reduced horizontal dimensions is obtained compared to the tearing off of a grain in an isotropic structure. In addition, tearing off is made more difficult because the grain is more deeply included within the matrix formed by the other grains.

Advantageously, the carbon inclusions are discontinuous.

Preferably, the ratio between the width and the length of the carbon inclusions is 1:1.2, advantageously greater than 1:20 and more advantageously greater than 1:30.

Advantageously, the support substrate exhibits a concentration gradient of the carbon inclusions, such that the density of the carbon inclusions increases from the front face towards the rear face.

In certain embodiments, only a portion of the support substrate comprises said carbon inclusions and the support substrate further comprises a portion devoid of carbon inclusions between the surface layer of monocrystalline SiC and the portion comprising the carbon inclusions.

Preferably, the volume ratio of the carbon inclusions in the support substrate is between 1% and 40%, preferably between 1% and 20%.

Another aspect of the present invention provides an electronic device comprising a substrate as described above and at least one radiofrequency or power electronics component formed in or on the surface layer, and a heat removal device, the substrate being brazed to the heat removal device via a filler material such that the filler material is in integral contact with at least a part of the portion comprising carbon inclusions on the rear face of the support substrate.

BRIEF DESCRIPTION OF THE FIGURES

Other features and advantages of the invention will become apparent from the detailed description which follows, with reference to the appended drawings, in which:

Figure 1 illustrates a device comprising two electronic components produced from a substrate according to the invention and a heat dissipation stack.

Figure 2A illustrates a substrate according to a first embodiment.

Figure 2B illustrates a substrate according to a second embodiment.

Figure 2C illustrates a substrate according to a third embodiment.

Figures 3A to 3D illustrate the steps for producing a support substrate according to the invention.

Figures 4A to 4C illustrate the steps for assembling the support substrate with the surface layer.

Figure 5 is a graph of the various silicon carbide phases obtained during a CVD process as a function of the temperature and the gas composition in the deposition chamber.

DETAILED DESCRIPTION OF EMBODIMENTS

Figure 1 illustrates a radiofrequency or power electronics device comprising one or more electronic chips 11, 12 produced from a substrate according to the invention. The chips may be connected via interconnections. In the case of a radiofrequency device, the electronic chip may carry a lateral gallium nitride device.

The electronic chips 11, 12 are mounted on a heat-dissipating structure by brazes 22, 23. This dissipating structure (DBC, acronym for "Direct Bonded Copper") comprises two copper metallizations 17, 19 and a substrate 18 made of a thermally conductive and electrically insulating ceramic, for example made of aluminum nitride. Electrical connections 27, 28 are fixed to the copper metallization 17 by means of brazes 25, 26.