solution for reducing these parasitic resonances is to increase the thickness of the $LiTaO_3$ layer; since this entails also increasing the thickness of the Si substrate in order to retain the improvements in the TCF, the total thickness of the hybrid substrate is no longer compatible with the requirements of thickness reduction of the final components, in particular for catering to the mobile phone market. Another solution, proposed by K. Hashimoto et al. (abovementioned article) is to roughen the lower surface of the $LiTaO_3$ layer (at the bonding interface with the substrate) so as to limit the reflections of the acoustic wave thereon.

OBJECTIVE OF THE INVENTION

One objective of the present invention is to provide an alternative solution to the solutions of the prior art. One objective of the invention is in particular to provide a hybrid structure that enables the reduction and/or the elimination of said parasitic acoustic waves.

BRIEF DESCRIPTION OF THE INVENTION

An aspect of ~~T~~the present invention relates to a hybrid structure for a surface acoustic wave device comprising a working layer of piezoelectric material assembled with a support substrate having a lower coefficient of thermal expansion than that of the working layer, and an intermediate layer located between the working layer and the support substrate. The hybrid structure is notable in that the intermediate layer is a sintered composite layer, formed from powders of at least a first material and a second material different from the first, wherein:~~.~~

~~According to advantageous features of the invention, taken alone or in combination:~~

- ~~the first material has a similar acoustic impedance to that of the working layer; the ratio between the acoustic impedance of the working layer and the acoustic impedance of the second material is greater than 2; and the mean size of the particles of the powders of the first and the second material is greater than or equal to a quarter of the wavelength of the acoustic signal intended to propagate at the surface of the surface acoustic wave device.~~

Another aspect of the present invention relates to a hybrid structure for a surface acoustic wave device comprising a working layer of piezoelectric material assembled with a support substrate having a lower coefficient of thermal expansion than that of the working layer, and an intermediate layer located between the working layer and the support substrate. The hybrid structure is notable in that the intermediate layer is a sintered composite layer, formed from powders of at least a first material and a second material different from the first, wherein:

- the first material and the second material are selected so as to form an acoustic impedance matching layer between the working layer and the support substrate; the mean size of the particles of the powders of the first and the second material is less than a quarter of the wavelength of the acoustic signal intended to propagate at the surface of the surface acoustic wave device.

According to features of the invention:

- the support substrate comprises a material selected from silicon, glass, silica, sapphire, alumina, aluminium nitride.

- the working layer comprises a piezoelectric material selected from lithium tantalate ($LiTaO_3$), lithium niobate ($LiNbO_3$), quartz, zinc oxide (ZnO).
- the first and second materials are selected from silicon oxide, silicon nitride, silicon, silicon carbide, alumina, germanium, sapphire, zirconium.
- the composite layer has a thickness of between a few hundreds of nanometres and several tens of microns.

Another aspect of ~~T~~the invention ~~also~~ relates to a process for manufacturing a hybrid structure for a surface acoustic wave device comprising the following steps:

i) providing a working layer of piezoelectric material and a support substrate having a lower coefficient of thermal expansion than that of the working layer;

ii) depositing a layer formed from a mixture of powders of at least a first material and a second material, different from the first, on a first face of the working layer and/or on a first face of the support substrate;

iii) sintering the layer formed from the mixture of powders to obtain a sintered composite layer firmly attached to the first face of the working layer and/or to the first face of the support substrate;

iv) assembling the working layer and the support substrate, so that the composite layer is positioned between the working layer and the support substrate, wherein:

- the first material has a similar acoustic impedance to that of the working layer,
- the ratio between the acoustic impedance of the working layer and the acoustic impedance of the second material is greater than 2,
- the mean size of the particles of the powders of the first and the second material is greater than or equal to a quarter of the wavelength of the acoustic signal intended to propagate at the surface of the surface acoustic wave device.

Another aspect of the present invention relates to process for manufacturing a hybrid structure for a surface acoustic wave device characterized in that it comprises the following steps:

i) providing a working layer of piezoelectric material and a support substrate having a lower coefficient of thermal expansion than that of the working layer;

ii) depositing a layer formed from a mixture of powders of at least a first material and a second material different

from the first on a first face of the working layer and/or on a first face of the support substrate;

iii) sintering the layer formed from the mixture of powders to obtain a sintered composite layer firmly attached to the first face of the working layer and/or to the first face of the support substrate;

iv) assembling the working layer and the support substrate, so that the composite layer is positioned between the working layer and the support substrate, wherein:

- the first material and the second material are selected so as to form an acoustic impedance matching layer between the working layer and the support substrate,
- the mean size of the particles of the powders of the first and the second material is less than a quarter of the wavelength of the acoustic signal intended to propagate at the surface of the surface acoustic wave device.

According to advantageous features of the invention, taken alone or in combination:

- the first face of the working layer and/or the first face of the support substrate comprises a protective layer, prior to the deposition of the layer formed from the mixture of powders from step ii).
- the protective layer is formed by at least one material selected from silicon nitride, a silicon oxynitride, a silicon oxide and alumina.
- the mixture of powders is in the form of a viscous paste, and the deposition of the layer formed by said mixture in step ii) is carried out by spin coating.

- the deposition of the layer formed by the mixture of powders is followed by a low-temperature heat treatment in order to discharge at least one liquid component of the viscous paste.

CLAIMS

1. A ~~H~~hybrid structure for surface acoustic wave device comprising a working layer of piezoelectric material assembled with a support substrate having a lower coefficient of thermal expansion than that of the working layer, and an intermediate layer located between the working layer and the support substrate, the hybrid structure being characterized in that the intermediate layer is a sintered composite layer, formed from powders of at least a first material and a second material different from the first, wherein:
    - the first material has a similar acoustic impedance to that of the working layer,
    - the ratio between the acoustic impedance of the working layer and the acoustic impedance of the second material is greater than 2,
    - the mean size of the particles of the powders of the first and the second material is greater than or equal to a quarter of the wavelength of the acoustic signal intended to propagate at the surface of the surface acoustic wave device.

~~2. Hybrid structure for surface acoustic wave device according to the preceding claim, in which:~~
    - ~~the first material has a similar acoustic impedance to that of the working layer,~~
    - ~~the ratio between the acoustic impedance of the working layer and the acoustic impedance of the second material is greater than 2,~~
    - ~~the mean size of the particles of the powders of the first and the second material is greater than or equal to a quarter of the wavelength of the acoustic signal~~

~~intended to propagate at the surface of the surface acoustic wave device.~~

~~3~~2. ~~Hybrid structure for surface acoustic wave device according to Claim 1~~A hybrid structure for surface acoustic wave device comprising a working layer of piezoelectric material assembled with a support substrate having a lower coefficient of thermal expansion than that of the working layer, and an intermediate layer located between the working layer and the support substrate, the hybrid structure being characterized in that the intermediate layer is a sintered composite layer, formed from powders of at least a first material and a second material different from the first, in which:

- the first material and the second material are selected so as to form an acoustic impedance matching layer between the working layer and the support substrate,
- the mean size of the particles of the powders of the first and the second material is less than a quarter of the wavelength of the acoustic signal intended to propagate at the surface of the surface acoustic wave device.

~~4~~3. The ~~H~~hybrid structure for surface acoustic wave device according to ~~one of the preceding claims~~claim 1 or 2, in which the support substrate comprises a material selected from silicon, glass, silica, sapphire, alumina, aluminium nitride.

~~5~~4. The ~~H~~hybrid structure for surface acoustic wave device according to one of the preceding claims, in which the working layer comprises a piezoelectric material selected from lithium tantalate ($LiTaO_3$), lithium niobate ($LiNbO_3$), quartz, zinc oxide (ZnO).

~~6~~5. The ~~H~~hybrid structure for surface acoustic wave device according to one of the preceding claims, in which the first and second materials are selected from silicon oxide, silicon nitride, silicon, silicon carbide, alumina, germanium, sapphire, zirconium.

~~7~~6. A ~~P~~process for manufacturing a hybrid structure for a surface acoustic wave device characterized in that it comprises the following steps:

i) providing a working layer of piezoelectric material and a support substrate having a lower coefficient of thermal expansion than that of the working layer;

ii) depositing a layer formed from a mixture of powders of at least a first material and a second material different from the first on a first face of the working layer and/or on a first face of the support substrate;

iii) sintering the layer formed from the mixture of powders to obtain a sintered composite layer firmly attached to the first face of the working layer and/or to the first face of the support substrate;

iv) assembling the working layer and the support substrate, so that the composite layer is positioned between the working layer and the support substrate, wherein:

- the first material has a similar acoustic impedance to that of the working layer,
- the ratio between the acoustic impedance of the working layer and the acoustic impedance of the second material is greater than 2,
- the mean size of the particles of the powders of the first and the second material is greater than or equal to a quarter of the wavelength of the acoustic signal intended to propagate at the surface of the surface acoustic wave device.

7. A process for manufacturing a hybrid structure for a surface acoustic wave device characterized in that it comprises the following steps:

i) providing a working layer of piezoelectric material and a support substrate having a lower coefficient of thermal expansion than that of the working layer;

ii) depositing a layer formed from a mixture of powders of at least a first material and a second material different from the first on a first face of the working layer and/or on a first face of the support substrate;

iii) sintering the layer formed from the mixture of powders to obtain a sintered composite layer firmly attached to the first face of the working layer and/or to the first face of the support substrate;

iv) assembling the working layer and the support substrate, so that the composite layer is positioned between the working layer and the support substrate, wherein:

- the first material and the second material are selected so as to form an acoustic impedance matching layer between the working layer and the support substrate,
- the mean size of the particles of the powders of the first and the second material is less than a quarter of the wavelength of the acoustic signal intended to propagate at the surface of the surface acoustic wave device.

8. The ~~P~~process for manufacturing a hybrid structure for a surface acoustic wave device according to ~~the preceding~~ claim 6 or 7, in which the first face of the working layer and/or the first face of the support substrate comprises a protective layer, prior to ~~the~~ a deposition of the layer formed from the mixture of powders from step ii).

9. The ~~P~~process for manufacturing a hybrid structure for a surface acoustic wave device according to ~~the preceding~~ claim 8, in which the protective layer is formed by at least one material selected from silicon nitride, a silicon oxynitride, a silicon oxide and alumina.

10. The ~~P~~process for manufacturing a hybrid structure for a surface acoustic wave device according to one of ~~the preceding three~~ claims 6 to 9, in which the mixture of powders is in the form of a viscous paste, and the deposition of the layer formed by said mixture in step ii) is carried out by spin coating.

11. The ~~P~~process for manufacturing a hybrid structure for a surface acoustic wave device according to ~~the preceding~~ claim 10, in which ~~the~~ a deposition of the layer formed by the mixture of powders is followed by a low-temperature heat treatment in order to discharge at least one liquid component of the viscous paste.

12. The ~~P~~process for manufacturing a hybrid structure for a surface acoustic wave device according to one of ~~the preceding five~~ claims 6 to 11, in which a bonding layer is deposited on the composite layer, prior to the assembly step iv).

13. The ~~P~~process for manufacturing a hybrid structure for a surface acoustic wave device according to one of ~~the preceding six~~ claims 6 to 12, in which the working layer provided in step i) is a piezoelectric material donor substrate.

14. The ~~P~~process for manufacturing a hybrid structure for a surface acoustic wave device according to ~~the preceding~~ claim 13, comprising a step v) of thinning the donor substrate to

~~the~~ a desired thickness of the working layer for the manufacture of the acoustic wave device.