

EP 2 533 274 A1 discloses a chemical mechanical polishing aqueous dispersion comprising (A) silica particles that include at least one functional group selected from a group consisting of a sulfo group and salts thereof, and (B) an acidic compound.

Objects of the embodiments disclosed herein

- 5 One of the objects of the embodiments disclosed herein is to provide a CMP composition and a CMP process especially for the chemical-mechanical polishing of III-V materials, particularly GaAs and InP substrates which are utilized in the front-end-of-line (FEOL) IC production to form transistors, and showing an improved polishing performance, especially
- (i) a high material removal rate (MRR) of a III-V material, for example GaAs and/or InP,
 - 10 (ii) high surface quality of the III-V material, for example GaAs and/or InP, after the CMP step,
 - (iii) safe handling and reduction of hazardous by-products – for example the toxic gasses AsH_3 and/or PH_3 in case of polishing GaAs and/or InP – to a minimum, or
 - (iv) or the combination of (i), (ii) and (iii).
- 15 Moreover, a CMP process was sought that is easy to apply and requires as few steps as possible.

Summary

~~According to a first aspect of the present disclosure, a~~ chemical-mechanical polishing (CMP) composition is provided comprising the following components:

- 20 (A) surface modified silica particles having a negative zeta potential of -15 mV or below at a pH in the range of from 2 to 6,
- (B) N,N,N',N'-tetrakis-(2-hydroxypropyl)-ethylenediamine or methanesulfonic acid,
- (C) water,
- (D) optionally one or more further constituents,

25 wherein the pH of the composition is in the range of from 2 to 6.

In an aspect, there is provided the use of a chemical-mechanical polishing (CMP) composition for polishing a substrate or layer containing one or more III-V materials wherein the chemical-mechanical polishing composition comprises the following components:

- 30 (A) surface modified silica particles having a negative zeta potential of -15 mV or below at a pH in the range of from 2 to 6,
- (B) N,N,N',N'-tetrakis-(2-hydroxypropyl)-ethylenediamine or methanesulfonic acid,
- (C) water,
- (D1) hydrogen peroxide in an amount of from 0.01 to 5 wt.-% based on the total weight of the CMP composition,

(D) optionally one or more further constituents,

wherein the pH of the composition is in the range of from 2 to 6 and wherein the surface modified silica particles of component (A) having a negative zeta potential of -15 mV or below at a pH in the range of from 2 to 6 are silica particles anionically modified with metallate ions or modified with sulfonic acid.

In a further aspect, the present disclosure relates to the use of N,N,N',N'-tetrakis-(2-hydroxypropyl)-ethylenediamine or methanesulfonic acid as an additive for a chemical-mechanical polishing (CMP) composition, preferably as an additive for a chemical-mechanical polishing (CMP) composition comprising surface modified silica particles having a negative zeta potential of -15 mV or below at a pH in the range of from 2 to 6. A preferred use as defined above is the use of N,N,N',N'-tetrakis-(2-hydroxypropyl)-ethylenediamine or methanesulfonic acid as an additive for a chemical-mechanical polishing (CMP) composition, wherein the addi

tive is an additive for increasing the removal rate of a III-V material, wherein the III-V material is preferably selected from the group consisting of GaN, GaP, GaAs, GaSb, AlAs, AlN, InP, InAs, InSb, InGaAs, InAlAs, AlGaAs, GaAlN, GaInN, InGaAlAs, InGaAsP, InGaP, AlInP, GaAlSb, GaInSb, GaAlAsSb and GaInAsSb.

5 | According to a further aspect embodiment of the disclosure there is provided a process for the manufacture of semiconductor devices comprising the chemical-mechanical polishing of a substrate or layer in the presence of a chemical-mechanical polishing (CMP) composition as defined hereinabove or hereinbelow.

10 | In a further aspect, there is provided a process for the manufacture of semiconductor devices comprising the chemical-mechanical polishing of a substrate or layer in the presence of a chemical-mechanical polishing (CMP) composition as defined above, wherein the substrate or layer contains one or more III-V materials.

15 | Generally, the semiconductor device which can be manufactured by the process as defined above is not particularly limited. Thus the semiconductor devices can be electronic components comprising semiconducting materials, as for example silicon, germanium, and III-V materials. Semiconductor devices can be those which are manufactured as single discrete devices or those which are manufactured as integrated circuits (ICs) consisting of a number of devices manufactured and interconnected on a wafer. Semiconductor devices can be two terminal devices for example a diode, three terminal devices for example a bipolar transistor, four terminal devices for example a Hall effect sensor or multi-terminal devices. Preferably, said semiconductor device is a multi-terminal device. Multi-terminal devices can be logic devices as integrated circuits and microprocessors or memory devices as random access memory (RAM), read only memory (ROM) and phase change random access memory (PCRAM). Preferably said semiconductor device is a multi-terminal logic device. In particular said semiconductor device is an integrated circuit or microprocessor.

25 | In an embodiment, the present disclosure relates to the use of a chemical-mechanical polishing (CMP) composition as defined hereinabove or hereinbelow for polishing a substrate or layer containing one or more III-V materials wherein the or at least one of or all III-V materials are preferably selected from the group consisting of GaN, GaP, GaAs, GaSb, AlAs, AlN, InP, InAs, InSb, InGaAs, InAlAs, AlGaAs, GaAlN, GaInN, InGaAlAs, InGaAsP, InGaP, AlInP, GaAlSb, GaInSb, GaAlAsSb, and GaInAsSb.

30 | ~~In a further aspect, there is provided the use of a chemical-mechanical polishing (CMP) composition as defined hereinabove or hereinbelow for polishing a substrate or layer containing one or more III-V materials.~~

35 | Preferred embodiments are explained in the claims and the specification. It is understood that combinations of preferred embodiments are within the scope of the present disclosure.

In a preferred process according to the present invention the substrate or layer contains one or more III-V materials. Preferably the one or at least one of or all the III-V materials are selected from the

group consisting of GaN, GaP, GaAs, GaSb, AlAs, AlN, InP, InAs, InSb, InGaAs, InAlAs, AlGaAs, GaAlN, GaInN, InGaAlAs, InGaAsP, InGaP, AlInP, GaAlSb, GaInSb, GaAlAsSb and GaInAsSb.

A semiconductor device can be manufactured by the process of the invention. Said process preferably comprises the chemical mechanical polishing of a substrate or layer – preferably a

Claims

1. Use of a Chemical-mechanical polishing (CMP) composition for polishing a substrate or layer containing one or more III-V materials wherein the chemical-mechanical polishing composition comprisescomprising the following components:
 - (A) surface modified silica particles having a negative zeta potential of -15 mV or below at a pH in the range of from 2 to 6,
 - (B) N,N,N',N'-tetrakis-(2-hydroxypropyl)-ethylenediamine or methanesulfonic acid,
 - (C) water,
 - (D1) hydrogen peroxide in an amount of from 0.01 to 5 wt.-% based on the total weight of the CMP composition,
 - (D) optionally one or more further constituents,

wherein the pH of the composition is in the range of from 2 to 6 and wherein the surface modified silica particles of component (A) having a negative zeta potential of -15 mV or below at a pH in the range of from 2 to 6 are silica particles anionically modified with metallate ions or modified with sulfonic acid.
2. ~~Chemical-mechanical polishing (CMP) composition according to claim 1, wherein the surface modified silica particles of component (A) having a negative zeta potential of -15 mV or below at a pH in the range of from 2 to 6 are silica particles anionically modified with metallate ions or modified with sulfonic acid. Use according to claim 1, wherein the or at least one or all of the III-V materials are selected from the group consisting of GaN, GaP, GaAs, GaSb, AlAs, AlN, InP, InAs, InSb, InGaAs, InAlAs, AlGaAs, GaAlN, GaInN, InGaAlAs, InGaAsP, InGaP, AlInP, GaAlSb, GaInSb, GaAlAsSb, and GaInAsSb.~~
3. ~~Use Chemical-mechanical polishing (CMP) composition according to claim 1 or 2, wherein the surface modified silica particles of component (A) having a negative zeta potential of -15 mV or below at a pH in the range of from 2 to 6 are silica particles anionically modified with metallate ions selected from the group consisting of aluminate, stannate, zincate, and plumbate.~~
4. ~~Use Chemical-mechanical polishing (CMP) composition according to any of claims 1, 2, or 3, wherein the surface modified silica particles of component (A) having a negative zeta potential of -15 mV or below at a pH in the range of from 2 to 6 are silica particles anionically modified with aluminate.~~
5. ~~Use Chemical-mechanical polishing (CMP) composition according to any preceding claim, wherein~~
 - the total amount of (A) surface modified silica particles having a negative zeta potential of -15 mV or below at a pH in the range of from 2 to 6 is in the range of from 0.1 wt % to 30 wt %, based on the total weight of the chemical-mechanical polishing (CMP) composition

and/or

 - the total amount of (B) N,N,N',N'-tetrakis-(2-hydroxypropyl)-ethylenediamine or methanesulfonic acid is in the range of from 0.01 to 3 wt % based on the total weight of the chemical-mechanical polishing (CMP) composition.
6. ~~Chemical-mechanical polishing (CMP) composition~~Use according to any preceding claim, wherein chemical-mechanical polishing (CMP) composition comprising one or more further constituents as component (D),

wherein the one or at least one of or all of the further constituents of component (D) are selected from the group consisting of oxidizing agents, abrasive materials different from surface modified silica particles having a negative zeta potential of -15 mV or below at a pH in the range of from 2 to 6, stabilizers, surfactants, friction reducing agents, buffer substances.

7. Use of N,N,N',N'-tetrakis-(2-hydroxypropyl)-ethylenediamine or methanesulfonic acid as an additive for a chemical-mechanical polishing (CMP) composition, preferably as an additive for a chemical-mechanical polishing (CMP) composition comprising surface modified silica particles having a negative zeta potential of -15 mV or below at a pH in the range of from 2 to 6.

~~8. Use according to claim 7, wherein the additive is an additive for increasing the removal rate of a III-V material.~~

98. Use according to claim 87, wherein the III-V material is preferably selected from the group consisting of GaN, GaP, GaAs, GaSb, AlAs, AlN, InP, InAs, InSb, InGaAs, InAlAs, AlGaAs, GaAlN, GaInN, InGaAlAs, InGaAsP, InGaP, AlInP, GaAlSb, GaInSb, GaAlAsSb, and GaInAsSb.

~~409.~~ Process for the manufacture of semiconductor devices comprising the chemical-mechanical polishing of a substrate or layer in the presence of a chemical-mechanical polishing (CMP) composition as defined in any of claims 1 to 6, wherein the substrate or layer contains one or more III-V materials.

~~11. Process according to claim 10, wherein the substrate or layer contains one or more III-V materials.~~

~~4210.~~ Process according to ~~any of claims 10 and 11~~ claim 9, wherein the or at least one or all of the III-V materials is selected from the group consisting of GaN, GaP, GaAs, GaSb, AlAs, AlN, InP, InAs, InSb, InGaAs, InAlAs, AlGaAs, GaAlN, GaInN, InGaAlAs, InGaAsP, InGaP, AlInP, GaAlSb, GaInSb, GaAlAsSb, and GaInAsSb.

~~13. Use of a chemical-mechanical polishing (CMP) composition as defined in any of claims 1 to 6 for polishing a substrate or layer containing one or more III-V materials.~~

~~14. Use according to claim 13, wherein the or at least one or all of the III-V materials are selected from the group consisting of GaN, GaP, GaAs, GaSb, AlAs, AlN, InP, InAs, InSb, InGaAs, InAlAs, AlGaAs, GaAlN, GaInN, InGaAlAs, InGaAsP, InGaP, AlInP, GaAlSb, GaInSb, GaAlAsSb, and GaInAsSb.~~