JP 2002-025954 A discloses an alkaline composition for polishing GaAs comprising

- polyethylene glycol $-(CH_2CH_2O)_n$ ($n \geq 1$),
- or 2-methoxyethanol $CH_3O(CH_2CH_2O)H$,
- or *N,N*-diethanol methanamide $CH_3N(CH_2CH_2OH)_2$,
- or a mixture of 2-methoxyethanol and *N,N*-diethanol methanamide

as non-ionic surfactant.

US 2008/124913 A1 discloses an abrasive slurry including a non-ionic surfactant that selectively forms a passivation layer on the polysilicon layer and a method for removing an upper portion of a polysilicon layer formed over a pattern to form a polished polysilicon surface.

Objects ~~of the invention~~

One of the objects of the ~~present invention~~embodiments disclosed herein was to provide a CMP composition and a CMP process appropriate for the chemical-mechanical polishing of III-V materials, particularly GaAs substrates, and showing an improved polishing performance, especially

(i) a high material removal rate (MRR) of the III-V material, for example GaAs,
(ii) a low static etch rate (SER) of the III-V material, for example GaAs,
(iii) high surface quality of the III-V material, for example GaAs, after the CMP step,
(iv) safe handling and reduction of hazardous by-products – for example the toxic gas AsH_3 in case of GaAs polishing – to a minimum, or
(v) or the combination of (i), (ii), (iii) and (iv).

Moreover, a CMP process was sought that is easy to apply and requires as few steps as possible.

Summary ~~of the invention~~

~~Accordingly,~~In a first aspect, there is provided a process for the manufacture of semiconductor devices comprising the chemical-mechanical polishing of a substrate or layer containing at least one III-V material in the presence of a chemical-mechanical polishing composition (CMP) composition (Q1) comprising

(A) inorganic particles, organic particles, or a mixture or composite thereof,
(B) at least one amphiphilic non-ionic surfactant having
  (b1) at least one hydrophobic group; and
  (b2) at least one hydrophilic group selected from the group consisting of polyoxyalkylene groups comprising
    (b22) oxyalkylene monomer units other than oxyethylene monomer units; and
(M) an aqueous medium.

Moreover, the use of the CMP composition (Q1) for chemical-mechanical polishing of a substrate or layer containing at least one III-V material was found.

In a second aspect, there is provided the use of the chemical-mechanical polishing composition (Q1) comprising

(A) inorganic particles, organic particles, or a mixture or composite thereof,

(B) at least one amphiphilic non-ionic surfactant having

(b1) at least one hydrophobic group; and

(b2) at least one hydrophilic group selected from the group consisting of polyoxyalkylene groups comprising

(b22) oxyalkylene monomer units other than oxyethylene monomer units; and

(M) an aqueous medium

for chemical-mechanical polishing of a substrate or layer containing at least one III-V material.

~~On the other hand~~In a third aspect, there is provided, a process for the manufacture of semiconductor devices comprising the chemical-mechanical polishing of a substrate or layer containing at least one III-V material in the presence of a chemical mechanical polishing (CMP) composition (Q2) comprising

(A) inorganic particles, organic particles, or a mixture or composite thereof,

(C) at least one amphiphilic non-ionic polyoxyethylene surfactant having

(c1) at least one hydrophobic group which is an alkyl group having not more than 8 carbon atoms; and

(c2) at least one hydrophilic group which is a polyoxyethylene group; and

(M) an aqueous medium.

Furthermore, the use of the CMP composition (Q2) for chemical-mechanical polishing of a substrate or layer containing at least one III-V material was found.

In a fourth aspect, there is provided the use of the chemical-mechanical polishing composition (Q2) comprising

(A) inorganic particles, organic particles, or a mixture or composite thereof,

(C) at least one amphiphilic non-ionic polyoxyethylene surfactant having

(c1) at least one hydrophobic group which is an alkyl group having not more than 8 carbon atoms; and

(c2) at least one hydrophilic group which is a polyoxyethylene group; and

(M) an aqueous medium

for chemical-mechanical polishing of a substrate or layer containing at least one III-V material.

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 invention.

A semiconductor device can be manufactured by the process of the invention, said process comprises the chemical mechanical polishing of a substrate or layer – preferably a layer – containing at least one III-V material in the presence of the CMP composition (Q1) or (Q2). If the III-V material has the shape of a layer, the content of all III-V material contained in the layer is preferably more than 90%, more preferably more than 95%, most preferably more than 98%, particularly more than 99%, for example more than 99.9% by weight of the corresponding layer. A III-V material is a material consisting of at least one group 13 element (including Al, Ga, In) and at least one group 15 element (including N, P, As, Sb). Thus in other words according to the invention a III-V material is a combination of at least one group 13 element and of at least one group 15 element. The terms "group 13" and "group 15" refer to the current IUPAC convention for naming the groups in the periodic table of chemical elements. Preferably, said III-V material is GaN, GaP, GaAs, GaSb, AlAs, AlN, InP, InAs, InSb, InGaAs, InAlAs, AlGaAs, GaAlN, GaInN, InGaAlAs, InGaAsP, InGaP, AlInP, GaAlSb, GaInSb, GaAlAsSb, or GaInAsSb. More preferably, said III-V material is GaN, GaP, GaAs, GaSb, InP, InAs, InSb, InGaAs, or InAlAs. Most preferably, said III-V material is GaN, GaP, GaAs, GaAs, InP, or InAs. Particularly, said III-V material is GaAs (gallium arsenide).

The CMP composition (Q1) or (Q2) is used for chemical-mechanical polishing of a substrate or layer containing at least one III-V material, preferably for chemical-mechanical polishing of a layer containing at least one III-V material. If the III-V material has the shape of a layer, the content of all III-V material contained in the layer is preferably more than 90%, more preferably more than 95%, most preferably more than 98%, particularly more than 99%, for example more than 99.9% by weight of the corresponding layer. Preferably, said III-V material is GaN, GaP, GaAs, GaSb, AlAs, AlN, InP, InAs, InSb, InGaAs, InAlAs, AlGaAs, GaAlN, GaInN, InGaAlAs, InGaAsP, InGaP,