Objects of the ~~invention~~embodiments disclosed herein

One of the objects of the ~~present invention~~embodiments disclosed herein was 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 the III-V material, for example GaAs and /or InP,
(ii) a high selectivity between different III-V materials (i.e. a high ratio between the material removal rates of said different III-V materials), e.g. a high selectivity of GaAs over InP,
(iii) high surface quality of the III-V material, for example GaAs and/or InP, after the CMP step,
(iv) 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
(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~~

According to a first aspect of the present ~~invention~~disclosure, a chemical-mechanical polishing (CMP) composition is provided comprising 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) one or more polyethylene imines,

(C) water,

(D) optionally one or more further constituents,

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

In a further aspect, the present ~~invention~~ disclosure relates to the use of a polyethylene imine 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. Preferably, the polyethylene imine has an average molecular weight in the range of from 500 g/mol to 40000 g/mol and is preferably a branched spherical polymer.

According to a further aspect of the ~~invention~~ 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.

Generally, the semiconductor device which can be manufactured by the process ~~according to the invention~~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.

In a further aspect, the present ~~invention~~ 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 one 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.

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~~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 layer – containing one or more III-V materials in the presence of the CMP composition as defined hereinabove or hereinbelow.

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). The terms “group 13” and “group 15” refer to the current IUPAC convention for naming the groups in the periodic table of chemi