formed during polishing and balance water. Example Slurries 1 to 7 having a pH of 8 or 9 and comprising – inter alia –
(a) benzene-1,2,4-tricarboxylic acid,
(b) Disponil™ FES surfactant (a fatty alcohol polyglycol ether sulphate, Na-salt, i.e. an anionic surfactant) manufactured by Cognis Chemical Group as a surfactant,
(c) benzotriazole,
(d) silica as abrasive, and
(e) hydrogen peroxide as oxidizing agent
were also disclosed.

US 2009/311864 A1 discloses a polishing slurry used in chemical mechanical polishing of a barrier layer and an interlayer dielectric film in a semiconductor integrated circuit, the polishing slurry comprising: an abrasive; an oxidizer; an anticorrosive; an acid; a surfactant; and an inclusion compound, wherein the polishing slurry has a pH of less than 5. Examples EX 17 and EX comprising
- colloidal silica as the abrasive,
- 1-[N,N-bis(hydroxyethyl)aminomethyl]benzotriazole (HEABTA),
- 2,5-furane-dicarboxylic acid,
- alkyl diphenyl ether disulfonic acid as an anionic surfactant,
- a specific di-quaternary cation (A17 and A27),
- hydrogen peroxide as the oxidizer, and
- cyclodextrin as the inclusion compound
were also disclosed.

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 appropriate for the chemical-mechanical polishing of substrates used in the semiconductor industry, particularly substrates comprising

(1) copper, and/or

(2) tantalum, tantalum nitride, titanium, titanium nitride, ruthenium, cobalt, or alloys thereof,

and showing an improved polishing performance, especially

(i) a high material removal rate (MRR) of the substrate to be preferably polished, for example tantalum nitride,

(ii) a low material removal rate (MRR) of the substrate not to be preferably polished, for example copper and/or low k material,

(iii) safe handling and reduction of hazardous by-products to a minimum, or

(iv) the combination of (i), (ii), (iii).

Furthermore, the CMP composition should be a stable formulation or dispersion where no phase separation should occur. Moreover, a CMP process was sought that is easy to apply and requires as few steps as possible.

As far as barrier layers and low-k or ultra-low-k materials are present in the semiconductor substrate used, the CMP composition of the present disclosure~~invention~~ should preferably remove the barrier layers and maintain the integrity of the low-k and ultra-low-k materials, i.e., it should have a particularly high selectivity of barrier layer over low-k or ultra-low-k materials with regard to the MRRs. Particularly, as far as copper layers, barrier layers and low-k or ultra-low-k materials are present in the substrate to be polished, the CMP composition of the present disclosure~~invention~~ should show the combination of as many as possible of the following properties: (a) high MRR of barrier layer, (b) low MRR of copper layer, (c) low MRR of low-k or ultra-low-k materials, (d) high selectivity of barrier layer over copper layer with regard to MRR, (e) high selectivity of barrier layer over low-k and ultra-low-k materials with regard to MRR. Most particularly, as far as copper layers, tantalum or tantalum nitride layers and low-k or ultra-low-k materials are present in the substrate to be polished, the CMP composition of the present disclosure~~invention~~ should show the combination of as many as possible of the following properties: (a') high MRR of tantalum or tantalum nitride, (b') low MRR of copper layer, (c') low MRR of low-k or ultra-low-k materials, (d') high selectivity of tantalum or tantalum nitride over copper with regard to MRR, and (e') high selectivity of tantalum nitride over low-k or ultra-low-k materials with regard to MRR. Furthermore, the CMP composition of the present disclosure~~invention~~ should show a long shelf life, while high MRR of barrier layer is maintained.

Summary ~~of the invention~~

Accordingly, a chemical mechanical polishing (CMP) composition (Q) was found which comprises

(A) inorganic particles, organic particles, or a mixture or composite thereof, wherein the particles are cocoon-shaped,

(B) a non-ionic surfactant,

(C) an aromatic compound comprising at least one acid group (Y), or a salt thereof, and

(M) an aqueous medium.

In a first aspect, there is provided a chemical mechanical polishing (CMP) composition (Q) comprising

(A) inorganic particles, organic particles, or a mixture or composite thereof, wherein the particles are cocoon-shaped,

(B) a non-ionic surfactant,

(C) an aromatic compound comprising per aromatic ring at least one acid group (Y) and at least one further functional group (Z) which is different from acid group (Y) and

(M) an aqueous medium.

In addition, a process for the manufacture of a semiconductor device comprising the chemical mechanical polishing of a substrate in the presence of the CMP composition (Q) was found, which fulfills the objects of the ~~invention~~embodiments disclosed herein.

In a second aspect, there is provided a process for the manufacture of semiconductor devices comprising the chemical mechanical polishing of a substrate (S) in the presence of a CMP composition as defined above.

Moreover, the use of the CMP composition (Q) for polishing substrates which are used in the semiconductor industry has been found, which fulfills the objects of the ~~invention~~embodiments disclosed herein.

In a third aspect, there is provided the use of a CMP composition as defined above for chemical mechanical polishing of a substrate (S) used in the semiconductor industry.

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.