a higher removal rate due to their rough surface while maintaining the same defectivity thanks to equivalent size distributions compared to dispersions of smooth surface cerium oxide particles having no shell in accordance with the present disclosure.

The dispersions of cerium based core-shell particles of the present disclosure can be used to prepare powders of cerium based core-shell particles, as well as polishing compositions, as it will be detailed hereafter in the specification.

In one aspect, there is provided a polishing composition comprising a dispersion of cerium based core-shell particles described herein or a cerium based core-shell particles powder described herein.

In another aspect, there is provided a use of the dispersion of cerium based core-shell particles described herein or of the cerium based core-shell particles powder described herein for the preparation of a polishing composition, more particularly a chemical mechanical polishing composition.

In yet another aspect, there is provided a method of removing a portion of a substrate, the method comprising polishing the substrate with a polishing composition prepared from a dispersion described herein or from a dispersion prepared from a core-shell cerium oxide particles powder described herein.

Additionally, one advantage of the core-shell particles of the present disclosure is that the nanoparticles from the shell are well attached to the core particle. It has notably been observed that they remain attached to the core during the whole chemical mechanical polishing process in which they are implemented. It is all the more important since the particles shells withstand the mechanical stress during the chemical mechanical polishing process. If the nanoparticles of the shell came off during the polishing, these small cerium oxide particles could remain attached to the substrate even after a washing step, which is not acceptable by the end users. It would result in unacceptable costs due to the substrate loss and the recurrent polishing composition replacement.

Another advantage of the core-shell particles of the present disclosure lies in the fact they have the adapted size range for the CMP application and are monodisperse.

FIGURES

Figures 1 is a TEM pictures of a dispersion of the core-shell particles of the invention obtained by the process illustrated in example 1, having a cerium oxide core and a cerium oxide shell.

Figure 2 is a TEM picture of a dispersion of particles of cerium oxide obtained by the process illustrated in counter example 1.

Figures 3 is a SEM picture of a dispersion of the cerium oxide particles intended to be used as core particles in the process illustrated in examples 1, 2 and 4.

Figure 4 is a SEM picture of a dispersion of the core-shell particles of the invention obtained by the process illustrated in example 1, having a cerium oxide core and a cerium oxide shell.

CLAIMS

1. A process for producing a dispersion of cerium based core-shell particles in a liquid, comprising the following steps:
   (a) providing an aqueous dispersion comprising particles of cerium oxide optionally doped with at least one metal (M); providing an aqueous solution comprising a cerium (III) salt; and optionally providing an aqueous solution comprising at least one metal (M') salt;
   (b) contacting, under oxidizing atmosphere, the aqueous dispersion with the aqueous solution(s) provided in step (a), while maintaining the temperature comprised between 0°C and 80°C and the pH lower or equal to 11, to produce the dispersion of cerium based core-shell particles;

   at least one of the steps (a) and (b) being carried out in the presence of nitrate ions.

2. Process according to claim 1, wherein the aqueous dispersion in step (a) comprises at least 3 wt%, in particular at least 5 wt%, in particular at least 10 wt %, in particular at least 15 wt%, more particularly at least 20 wt% of particles of cerium oxide optionally doped with at least one metal (M) relative to the total weight of the aqueous dispersion.

3. Process according to claim 1 or 2, wherein the particles provided in the aqueous dispersion in step (a) are particles of cerium oxide.

4. Process according to claim 1 or 2, wherein the particles provided in the aqueous dispersion in step (a) are particles of cerium oxide doped with at least one metal (M) chosen from the group consisting of alkali metal elements, alkaline earth metal elements, rare earth elements, actinide elements, transition metal elements and post transition metal elements, from the Periodic Table.

5. Process according to claim 4, wherein the metal (M) is chosen from the group consisting of Zr, Al, La, Pr, Nd, Y, and Sr.

6. Process according to claim 4 or 5 wherein the molar ratio M / (M+Ce) in the particles provided in the aqueous dispersion in step (a) is comprised between 0.01 and 0.15, preferably between 0.01 and 0.12.

7. Process according to any one of claims 1 to 6, wherein the aqueous solution comprising the at least one metal (M') salt is provided in step (a) and wherein the metal (M') is chosen from the group consisting of alkali metal elements, alkaline earth metal elements, rare earth elements, actinide elements, transition metal elements and post transition metal elements, from the Periodic Table.

8. Process according to claim 7, wherein the metal (M') is chosen from the group consisting of Zr, Al, La, Pr, Nd, Y, and Sr.

9. Process according to claim 7 or 8 wherein the molar ratio M'/(M'+ Ce) in the shell of the core-shell particles produced is comprised between 0.01 and 0.15, preferably between 0.01 and 0.12.

10. Process according to any one of claims 1 to 9 wherein the temperature in step (b) is maintained between 10°C and 60°C, more preferably between 15°C and 45°C, in particular between 20°C and 40°C, more particularly between 25°C and 35°C, even more particularly between 30°C and 35°C.

11. Process according to any one of claims 1 to 10, wherein the pH in step (b) is maintained between 3 and 11, in particular between 4 and 11, in particular between 8 and 11, in particular between 8 and 10, more particularly between 8 and 9.

12. Process according to any one of claims 1 to 11, wherein the molar ratio cerium oxide/cerium (III) before starting step (b) is comprised between 1/1 and 100/1, preferably between 3/1 and 30/1, preferably between 5/1 and 15/1.

13. Process according to any one of claims 1 to 12, further comprising, in any order, a step (c) of acidifying and/or a step (d) of washing the dispersion of cerium based core-shell particles.

14. Process according to any one of claims 1 to 13, further comprising a step (e) of deagglomeration of the cerium based core-shell particles.

15. Process according to any one of claims 1 to 14, further comprising a step (f) of drying the cerium based core-shell particles.

16. Dispersion of cerium based core-shell particles in a liquid obtainable by the process according to any one of claims 1 to 14, wherein each cerium based core-shell particle has a core particle made of cerium oxide optionally doped with at least one metal (M) and a shell consisting of a plurality of nanoparticles of cerium oxide optionally doped with at least one metal (M'), said nanoparticles being formed on the surface of the core particle, wherein the ratio of the average size of the core-shell particles measured by TEM to the average size of the core-shell particles measured by BET is of at least 1.5.

17. Cerium based core-shell particles powder obtainable by the process according to claim 15, wherein each cerium based core-shell particle has a core particle made of cerium oxide optionally doped with at least one metal (M) and a shell consisting of a plurality of nanoparticles of cerium oxide optionally doped with at least one metal (M'), said nanoparticles being formed on the surface of the core particle, wherein the ratio of the average size of the core-shell particles measured by TEM to the average size of the core-shell particles measured by BET is of at least 1.5.

18. Polishing composition comprising a dispersion of cerium based core-shell particles according to claim 16 or a cerium based core-shell particles powder according to claim 17.

19. Use of the dispersion of cerium based core-shell particles of claims 16 or of the cerium based core-shell particles powder of claim 17 for the preparation of a polishing composition, more particularly a chemical mechanical polishing composition.

20. Method of removing a portion of a substrate, the method comprising polishing the substrate with a polishing composition prepared from a dispersion according to claim 16 or from a dispersion prepared from a core-shell cerium oxide particles powder according to claim 17.