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(54) Title: NANOMETRIC-SIZED CERAMIC MATERIALS, PROCESS FOR THEIR SYNTHESIS AND USES THEREOF

(57) Abstract: The present invention concerns nanometric-sized ceramic materials in the form of multiple crystalline structures, composites, or solid solutions, the process for their synthesis, and uses thereof. These materials are mainly obtained by detonation of two water-in-oil (W/O) emulsions, one of which is prepared with precursors in order to present a detonation regime with temperature lower than 2000°C, and they present a high chemical and crystalline phase homogeneity, individually for each particle, as well as a set of complementary properties adjustable according to the final applications, such as a homogeneous distribution of the primary particles, very high chemical purity level, crystallite size below 50 nm, surface areas by mass unit between 25 and 500 m²/g, and true particle densities higher than 98% of the theoretical density. This set of characteristics makes this materials particularly suitable for a vast range of applications in the nanotechnology field, such as, for example, nanocoatings, magnetic nanofluids, nanocatalysts, nanosensors, nanopigments, nanoadditives, ultra light nanocomposites, drug release nanoparticles, nanomarkers, nanometric films, etc.



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CLAIMS

1. Process for the synthesis of nanometric-sized ceramic materials, **characterized in that** it is carried out by detonating two water-in-oil (W/O) emulsions, a first one and a second that contains a set of precursors of ceramic materials and presents a detonation regime at temperatures in the point C,J(Chapman, Jouguet) lower than the ceramic nanomaterial melting point , determined from the composition and density of the emulsion by means of the state equation and numerical methods.
2. The process according to claim 1, **characterized in that** the precursors of the second emulsion comprise oxidizing agents soluble in the internal aqueous phase, fuels soluble in the internal aqueous phase, fuels miscible with the external phase, and still solid precursors, such as metals and metal alloys.
3. The process to claim 1, **characterized in that** the definition of the composition of the second emulsion comprises the following stages:
 - a) defining the stequiometry of the precursors in the mixture;
 - b) adjusting the detonation temperature.
4. The process according to claim 1 and 3, **characterized in that** the pH of the second (W/O) emulsion is acid and lower than 5.
5. The process according to claim 1, **characterized in that** the first emulsion has the following composition:

- a) Amonium Nitrate: 70 to 90%;
- b) Water: 5 to 20%;
- c) Oil: 3 to 10%;
- d) Emulsifying Agent: 0.5 to 2.5%;
- e) Organic sensitizer: 0.2 to 1%.

6. The process according to claim 1, **characterized in that** the (1st) and (2nd) emulsions exhibit several configurations, such as but not limited to spherical, cylindrical, plane faces, and annular configurations.

7. The process according to claim 1, **characterized in that** the detonation is initiated in the first emulsion.

8. Ceramic materials of the type oxides with binary, ternary, or higher structure, or non-oxides, such as for example, nitrides, carbides, hydrides, or composites, or solid solutions, obtained by the process described in claims 1-7, **characterized in that** they exhibit:

- a) homogeneous distribution of primary particles between 15 and 100 nm;
- b) crystalline phase homogeneity, in each individual particle, higher than 90%;
- c) crystallite size lower than 50 nm;
- d) true density higher than 98% of the theoretical density;
- e) surface area by mass unit between 5 and 500 m²/g;
- f) a purity level higher than 99.99%.

9. Use of the ceramic materials obtained by the process described in claims 1-7 and described in claim 8 , **characterized in that** it is intended for:

- a) applications in catalytic systems in the biomaterials and nanomedicine fields,
- b) the production of nanometric films, such as sintering aids in ceramics industry, or
- c) the combination with structural materials, such as cement, polymers, rubber, for changing mechanical, electrical, magnetic, optical, and surface properties.

10. Second water-in-oil (W/O) emulsion, **characterized in that** it comprises as precursors oxidizing agents soluble in the internal aqueous phase, fuels soluble in the internal aqueous phase, fuels miscible with the external phase, and still solid precursors, such as metals and metal alloys, its internal phase has a pH lower than 3, the density is comprised between 0.7 and 1.7 g/cm³, and it presents a detonation regime with a reaction rate higher than 4000 m/s for a detonation temperature lower than the ceramic nanomaterial melting point.