WO 2011/127061 A1 relates to a method for enhancing the effect of radiation directed to a tissue or a population of cells comprising the steps of: (1) administering to an animal an amount of high-Z particles, the high-Z particles comprising a targeting molecule with an affinity for a targeted tissue or a targeted population of cells and a high-Z element; and (2) subsequently irradiating the targeted tissue or targeted population of cells with ionizing radiations; wherein the high-Z particles are administered to the animal in an amount sufficient to achieve a concentration in the targeted tissue or targeted population of cells of less than 0.05% metal by weight.

Inventors herein provide a new and powerful strategy to use their nanoparticles (herein below described) which are able to achieve a very efficient alteration or destruction of target cancerous cells in combination with ionizing radiations, when said nanoparticles are adequately selected and concentrated inside the targeted cancer site, as herein demonstrated.

SUMMARY OF THE INVENTION

In one aspect, there is provided a composition comprising inorganic nanoparticles having a volume (Vin) having an electron density at least 5 times the electron density of the corresponding volume 1 (Vw1) of water, wherein the nanoparticles provide more than 7×10^{22} electrons to the tumor volume, for use for inducing in a human subject having a tumor (i) the destruction of more than 70% of cancer cells in a tumor volume or (ii) at least more than 20% of tumor size reduction when the volume (Vc) of said composition occupies between 2 and 50% of the tumor volume (Vt) and when the tumor is exposed to ionzing radiations.

In another aspect, there is provided a use of a composition described herein in the manufacture of a medicament for (i) the destruction of more than 70% of cancer cells in a tumor volume or (ii) at least more than 20% of tumor size reduction when the volume (Vc) of said composition occupies between 2 and 50% of the tumor volume (Vt) and when the tumor is exposed to ionizing radiations, in a human subject having a tumor.

In another embodiment, there is provided an advantageous composition comprising inorganic particles for use for treating cancer, in particular a composition allowing the destruction of more than about 30%, preferably more than about 44% or more than about 47%, even more preferably more than about 70%, of cancer cells in a tumor volume of a subject (histological response assessment) or inducing at least more than 20% of tumor size reduction (anatomical response assessment) in a subject or inducing at least more than 20% of tumor ^{18}F-FDG SUV (Standardized Uptake Value) decline (metabolic response assessment) in a subject, when the tumor of said subject is exposed to ionizing radiations.

Once administered, the volume (Vc) of the composition of the invention occupies between 2 and 50% of the tumor volume (Vt). Each inorganic nanoparticle of the composition has a volume (Vin) having an electron density at least 5 times the electron density of the corresponding volume 1 (Vw1) of water.

In a particular embodiment, there is provided a method for inducing in a subject suffering of a cancer (i) the destruction of more than 30% of cancer cells in a tumor volume or (ii) at least more than 20% of tumor size reduction is herein described. This method comprises:

- administering in a subject suffering of a cancer a composition comprising inorganic nanoparticles, each of said inorganic nanoparticle having a volume (Vin) having an electron density at least 5 times the electron density of the corresponding volume 1 (Vw1) of water, and
- exposing the tumor (targeted tissue or targeted population of cells) of the subject to ionizing radiations,

thereby inducing (i) the destruction of more than 30% of cancer cells in a tumor volume or (ii) at least more than 20% of tumor size reduction when the volume (Vc) of said composition occupies between 2 and 50% of the tumor volume (Vt).

CLAIMS

1. Composition comprising inorganic nanoparticles having a volume (Vin) having an electron density at least 5 times the electron density of the corresponding volume 1 (Vw1) of water, wherein the nanoparticles provide more than 7×10^{22} electrons to the tumor volume, for use for inducing in a human subject having a tumor (i) the destruction of more than 70% of cancer cells in a tumor volume or (ii) at least more than 20% of tumor size reduction when the volume (Vc) of said composition occupies between 2 and 50% of the tumor volume (Vt) and when the tumor is exposed to ionizing radiations.

2. Composition according to claim 1, wherein said volume composition (Vc) has an electron density of at least 3% of the electron density of the corresponding volume 2 (Vw2) of water.

3. Composition according to claim 1 or 2, wherein the inorganic material of the nanoparticle has a theoretical (bulk) density of at least 7 and an effective atomic number (Z_{eff}) of at least 25.

4. Composition according to claim 3, wherein the inorganic material is selected from an oxide, a metal, a sulfide or any mixture thereof.

5. Composition according to anyone of claims 1 to 4, wherein the largest dimension of a nanoparticle is between about 5 nm and about 250 nm.

6. Composition according to anyone of claims 1 to 5, wherein the composition is a pharmaceutical composition in a liquid or gel form.

7. Composition according to anyone of claims 1 to 6, wherein the tumor is a malignant solid tumor or lymphatic cancer.

8. Composition according to anyone of claims 1 to 7, wherein inorganic nanoparticles are administered to the subject through a route selected from the intratumoral, the intraarterial or the intravenous route.

9. Composition according to anyone of claims 1 to 8, wherein ionizing radiations sources are selected from X-rays, typically X-rays of between 50 KeV and 6 MeV, ion beams, electron beams, gamma-rays, a radioactive isotope.

10. Use of a composition according to any one of claims 1-9 in the manufacture of a medicament for (i) the destruction of more than 70% of cancer cells in a tumor volume or (ii) at least more than 20% of tumor size reduction when the volume (Vc) of said composition occupies between 2 and 50% of the tumor volume (Vt) and when the tumor is exposed to ionizing radiations, in a human subject having a tumor.