Effective atomic number is a term that is similar to atomic number but is used for compounds (e.g. water) and mixtures of different materials (such as tissue and bone) rather than for atoms. Effective atomic number calculates the average atomic number for a compound or mixture of materials. It is abbreviated Z_{eff}.

The effective atomic number is calculated by taking the fractional proportion of each atom in the compound and multiplying that by the atomic number of the atom. The formula for the effective atomic number, Z_{eff}, is as follows:

$$Z_{eff} = \sqrt[2.94]{f_1 \times (Z_1)^{2.94} + f_2 \times (Z_2)^{2.94} + f_3 \times (Z_3)^{2.94} + \ldots}$$

where

f_n is the fraction of the total number of electrons associated with each element, and

Z_n is the atomic number of each element.

The atomic number (also known as the proton number) is the number of protons found in the nucleus of an atom. It is traditionally represented by the symbol Z. The atomic number uniquely identifies a chemical element. In an atom of neutral charge, atomic number is equal to the number of electrons.

An example is that of water (H_2O) which is made up of two hydrogen atoms (Z=1) and one oxygen atom (Z=8). The total number of electrons is 1+1+8 = 10. The fraction of electrons corresponding to the two hydrogens is 2/10 and the fraction of electrons corresponding to the unique oxygen is (8/10). Z_{eff} of water is therefore:

$$Z_{eff} = \sqrt[2.94]{0.2 \times 1^{2.94} + 0.8 \times 8^{2.94}} = 7.42$$

Z_{eff} participate to the incoming radiations absorption capacity of nanoparticles.

The inorganic material constituting the nanoparticle is typically selected from an oxide, a metal, a sulfide and any mixture thereof.

When the inorganic material constituting the nanoparticle is an oxide, this oxide is advantageously *selected from* Cerium (IV) oxide (CeO_2), Neodynium (III) oxide (Nd_2O_3), Samarium (III) oxide (Sm_2O_3), Europium (III) oxide ($Eu2O_3$), Gadolinium (III) oxide (Gd_2O_3), Terbium (III) oxide (Tb_2O_3), Dysprosium (III) oxide (Dy_2O_3), Holmium oxide (Ho_2O_3), Erbium oxide (Er_2O_3), Thullium (III) oxide (Tm_2O_3), Ytterbium oxide (Yb_2O_3), Lutetium oxide (lu_2O_3), Hafnium (IV) oxide (HfO_2), Tantalum (V) oxide (Ta_2O_5), Rhenium (IV) oxide (ReO_2), Bismuth (III) oxide (Bi_2O_3). In the context of the present invention, a mixture of inorganic oxides can also be used to prepare the nanoparticle of the invention.

When the inorganic material constituting the nanoparticle is *a metal, this metal is advantageously* selected from gold (Au), silver (Ag), platinum (Pt), palladium (Pd), tin (Sn), tantalum (Ta), ytterbium (Yb), zirconium (Zr), hafnium (Hf), terbium (Tb), thulium (Tm), cerium (Ce), dysprosium (Dy), erbium (Er), europium (Eu), holmium (Ho), iron (Fe), lanthanum (La), neodymium (Nd), praseodymium (Pr), lutetium (Lu). In the context of the present invention, mixture of metals is also